VANUATU FISHERIES RESOURCE PROFILES

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Sponsored by

The International Waters Programme of the Vanuatu node funded by GEF, Implemented by UNDP and executed by SPREP

The PREFACE

The International Waters Programme of the Vanuatu node funded by GEF implemented by UNDP and executed by SPREP was requested to provide funding assistance for the review and up date the "Republic of Vanuatu Fisheries Resource Profiles" prepared by Lui A. J Bell and Moses J. Amos in 1993. The purpose of the profiles were to:

- provide information for the Government on the level of fresh water and marine resources available for appropriate development planning and instigating regulatory controls for resource conservation and management;
- facilitate the dissemination of information and data that are required within government, local communities as well as regionally and internationally; and,
- facilitate the provision of concise and timely information required by potential investors.

The Terms of Reference for the review are as follows:

- Undertake library research to collate and assess all existing documentation, data. Images, etc.., which provides information relating to the resource identity, and abundance, distribution, exploitation, marketing and current management measures in Vanuatu;
- Based on the information examined and the Fisheries Resource Profile for Vanuatu prepared by FFA in 1991:
    i. provide and update list for fresh water and marine resources to include their identity, abundance and local distribution,
    ii. describe the utilization of the resources including the exploitation and marketing information of each resource, and;
    iii. describe current management (including proposed management plans) for each resource described.

The report was prepared in July 2004 and supposed to be only for a period of three weeks, however, given the amount of information, which needed to be included in the report, it took longer than anticipated. The profile provides an overview of the major marine resources identified as important to the commercial, artisanal and subsistence fisheries sectors within Vanuatu. As regards to freshwater resources, the report covers as much resoures as possible, regardless of their commercial value.

Each fisheries resource [1]is divided into four main categories:

(i) a brief description of the resource (species present, their distribution, biology and ecology);
(ii) an overview of the fishery (utilization, production and marketing);
(iii) the status of the stocks; and
(iv) management concerns (current legislation and policies regarding exploitation and recommended management options). In some cases a resource involves more than one species (e.g. aquarium fish and ornamental shells, eel fish).

The assistance and level of understanding provided by the staffs of the Department of Fisheries and the Environment Unit, particularly Mrs. Leah Nimoho was greatly appreciated. The author would also like to acknowledge the assistance provided by Ms. Beverleigh Kanas Liu for editing the profile.

The author assumes full responsibility for the content of this report. Opinions, where expressed are his alone and in no way reflect the policy of the International Waters Programme, Fisheries Department of Vanuatu, the Environment Unit or the Government of Vanuatu.

[1] Because of the inclusion of profiles for those resources that are not marine in nature, the wording "fisheries resources profiles" is used, which is more reflective of the contents of the report.

LIST OF ABBREVIATIONS AND ACRONYMS

A.C.I.A.R	Australian Center for International Agricultural Research
AIDAB	Australian International Development Assistance Bureau
AIMS -	Australian Institute of Marine Science
B.P.	Burns Philp (now Better Price)
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CPUE-	Catch per unit effort
CTL	cephalothoracic length (used in coconut crab measurement)
DP1 -	First National Development Plan (1982-1986)
DP2 -	Second National Development Plan (1987-1991)
DP3	Third National Development Plan (1992-1996)
EEZ -	Exclusive Economic Zone
EIA	Environment Impact Assessment
ELEFAN	*E*lectronic *L*ength *F*requency *An*alysis
FADs -	Fish Aggregating Devices
FAO -	Food and Agriculture Organisation of the United Nations
FAR	Fisheries Annual Report
FFA	Forum Fisheries Agency
FFA	South Pacific Forum Fisheries Agency
FOB	Free on board
GEF -	Global Environment Facility
ICLARM	International Centre for Living Aquatic Resources Management
ICOD	International Centre for Ocean Development
IUCN	International Union for Conservation of Nature
JAMARC	Japan Marine Fishery Resources Research Centre
JICA	Japan International Cooperation Agency
MSG -	Melanesian Spearhead Group
MSP	Melanesian Shell Products Ltd
MSY	Maximum Sustainable Yield
O.A.M	Open air market
OFCF	Overseas Fishery Cooperation Foundation
ORSTOM	French Scientific Research Institute for Co-operative Development
PNG	Papua New Guinea
PWD -	Public Works Department
RALC	Rural Alienated Land Committee
SCUBA	Self Contained Underwater Breathing Apparatus
SPADP	South Pacific Aquaculture Development Programme
SPC -	Secretariat of the Pacific Commiunity
SPFC -	South Pacific Fishing Company
TL	Thoracic length
U.S.A.-	United States of America
VFDP -	Village Fishery Development Programme
SECN	Northern Branch of South Equatorial Current
SECS	South Branch of South Equatorial Current
SECC	South Equatorial Counter Current
CMT	Custom Marine Tenure
UNCLOS	United Nations Convention on the Law os the Sea
LGC	Local Government Councils
WCPO	Western and Central Pacific Ocean
OFP	Oceanic Fisheries Programme
ITSL	International Tuna Services Limited
TOHO	
VMS	Vessel Monitoring System
EDF	
VFIL	Vanuatu Fishing Investment Limited
TAC	Total Allowable Catch
DWFN	Distant Water Fishing Nation
LTP	La Touque a Poissons

CONTENTS

1. EXECUTIVE SUMMARY

The Republic of Vanuatu consists of over eighty mountainous islands, mostly of volcanic and coralline origin, extending over an area of over 12,200 sq. km. Of this total area, 5,500 sq. km is considered arable land. The area of inner reefs and lagoons is approximately 448 sq. km. with mangroves covering an area of 25 sq. km. The Exclusive Economic Zone (EEZ) covers an area of 680,000 sq. km. but resolution on the sovereignty over Matthew and Hunter Islands (EEZ of about 190,000 sq. km.) would have a significant impact. The projected population in 1991 was 165,260 while that in 1989 was 142,630. The intercensal population growth rate between 1979 and 1988 was 2.4 percent.

The Fisheries Department is the sole agency responsible for the control (regulation), development and management of the fisheries resources within Vanuatu. However, consideration of the impacts from developments on the environment is the responsibility of the Environment Unit of the Ministry of Natural Resources. There is a possible overlap of responsibilities between the two agencies in certain areas like assessment work and conservation of species.

The First National Development Plan (DP1-1982-1986) concentrated on diversification to reduce the dependence on copra. In the Second Development Plan period (1987-1991) efforts were concentrated in maximising the sectors' contribution to an expansion in the nation's income-earning and employment opportunities with export possibilities. Development of a small locallybased ocean tuna fishery was envisaged.

The South Pacific Fishing Company (SPFC) was established in 1957 on Espiritu Santo as a cold storage and fishing support base for longliners fishing in the southwest Pacific for tuna for canneries. The company ceased to operate in 1987 when the fleet transferred its operation to American Samoa. Fishing by foreign fleets in Vanuatu waters has only been a low level activity. During the 1970's, the Vanuatu-based longliners took only a small portion (500-2,000 t per year) of their catch (up to 15,000 t per year) in Vanuatu waters. The Japanese pole-and-line fishing vessels also in the 1970's took only modest quantities of 300-1,600 tonnes of skipjack per year. Under an agreement with the Government, Russian purse-seiners claimed to have caught a total of 12 t of tuna within Vanuatu during the agreement period. A fee of US$1.5m was paid for the duration of this agreement. By December 2003, 132 long-line vessels were licensed to fish in Vanuatu waters. Vanuatu is a party of the Multilateral Fisheries Treaty with America. Research conducted on the bait fishery in the Republic indicated that the resource will not be able to support a large-scale pole-and-line fishery.

One of the major projects undertaken during the DP1 period was the establishment of the Village Fisheries Development Programme (VFDP) mainly for the off-shore bottom fishery. The project was estimated to have met 80 percent of the local requirements for fresh, high quality fish for the urban populations thus it has been successful in import substitution. Several researches have been conducted on the off-shore bottom-fish resources of Vanuatu and indications so far seem to indicate that the current level of exploitation has not reached the estimated maximum sustainable yield of about 730 tonnes per year. All of the catch from this fishery is marketed locally via several avenues. Provincial Fisheries Extension Centres in the outer islands, Santo fish market on Santo, Au Bon Marche in Vila and the LTP fish market in Vila are the main marketing channels of fisheries products. However, direct sales to restaurants and stores, especially those in Vila, are increasing due to better prices offered for the fishermen.

Fishing has always been considered secondary to agriculture in Vanuatu. However, a village subsistence fishing survey conducted in 1983 indicated that over 50 percent of the country's rural population engages in fishing. Apart from the collection of trochus and green snail for the production of button blanks etc. in local factories, most of the fishing within the reefs and lagoons has been on the subsistence/artisanal level. Reef and lagoon fishes as well as non-finfish animals such as lobsters are becoming increasingly important in the artisanal level. The current decreasing trend in the number of boats engaged in the bottom-fish fishery is a possible indication of the likely increased pressure on the inshore resources. Export of bêche-de-mer and aquarium fish has been relatively small and erratic in the past. However, recently they have become major marine products exported, particularly the aquarium fish trade. At present, trochus is one of the major

inshore resources in the Republic generating incomes for the rural communities. Although on a lower scale, higher prices are offered for green snails.

Due to the decline in prices of agricultural products, especially copra, coconut crabs have become a target species and form an important component of the income of the inhabitants of the more remote islands.

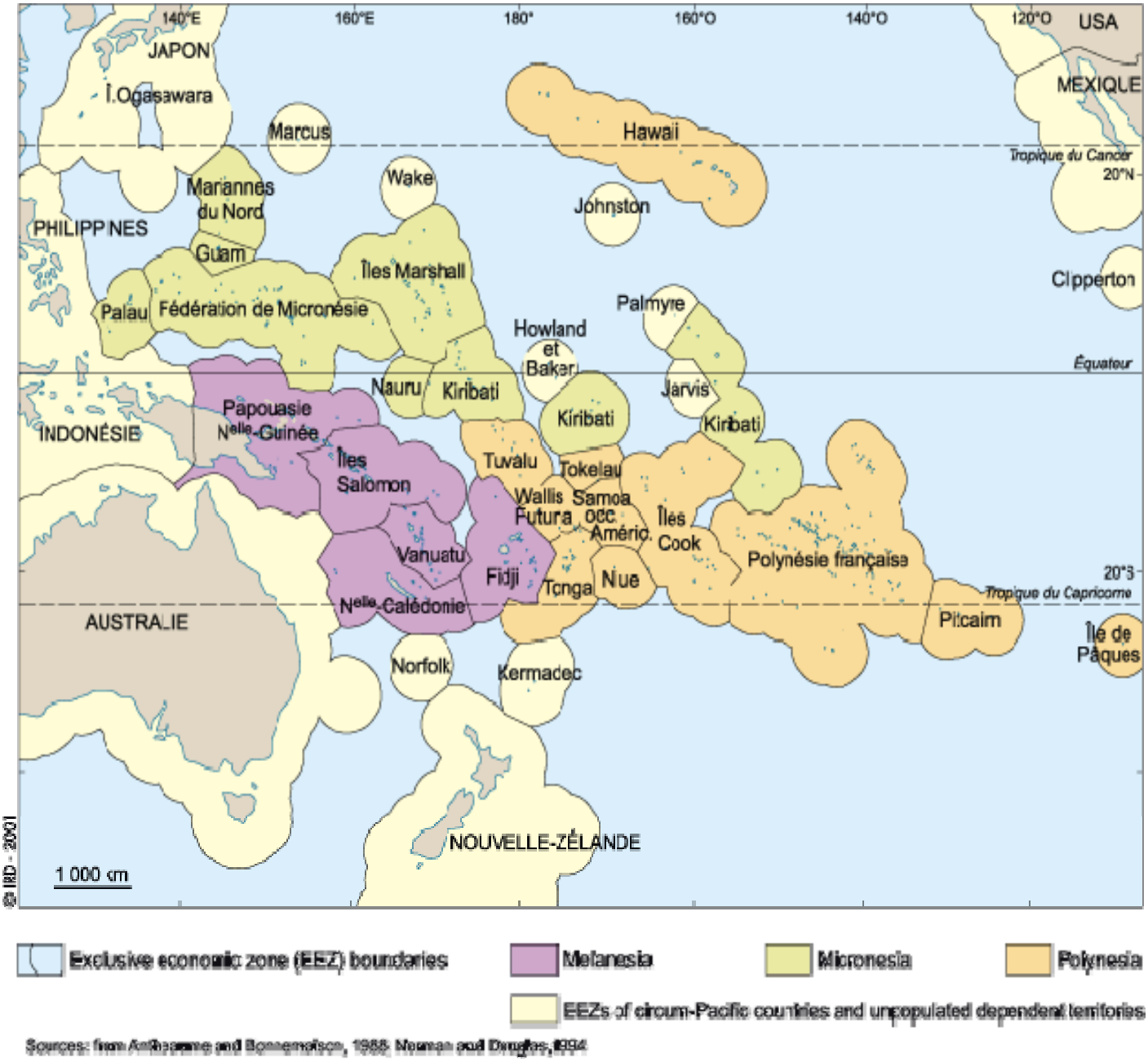
Two animal species have been introduced into Vanuatu in efforts to develop aquaculture initiatives in the Republic. These introductions of new species involved the marine Pacific oyster, *Crassostrea gigas* and the giant Malaysian fresh-water prawn, *Macrobrachium rosenbergii*. The oyster culture trials were conducted in three different areas but all failed due to poor growth, high mortality and predation. Good growth results were obtained from the trials conducted on Santo but predation and irregular spat supply were problematic. No information could be located on the failure of the *Macrobrachium* project but indications are that it may have been caused by high mortality and slow growth rates attained and possibly land disputes.

During the recent past, the Department of Fisheries has commenced studies on fresh water resources. Preliminary observations indicated that there is potential in development of aquaculture using the fresh water indigenous fish species. The Department of Fisheries has recently (2004) commenced research work on farming of imported Tilapia fish (*Nile Tilapia*) from the Fiji Fisheries Research Station. Aquaculture research on Tilapia is currently being undertaken at Erapo on Efate island. Aquaculture research on the local fresh water prawn, *Macrobrachium lar* is being undertaken on Sarate, South Santo. The Department of Fisheries' future intention would be to diversify to include importation of *Macrobrachium rosenbergii* from Fiji Fisheries Research station in Suva, Fiji.

Vanuatu was one of the countries included in the study conducted by the FAO/SPADP on the potential of green mussel aquaculture in 1989. The study indicated potential sites within the Republic, especially Erakor Lagoon, but water quality (pollution) could be a problem. The Fisheries Department currently operates a small-scale hatchery for three native mollusc species, *Trochus niloticus*; the green snails, *Turbo marmoratus* and *Tridacna crocea* and *maxima* species The hatchery work on these species is for re-seeding purposes.

The Fisheries Act 1983 is currently under review. This process would hopefully lead to changes that seem necessary in the Fisheries Regulations currently in force. There is clearly a need for coordination in this area with other agencies to define responsibilities clearly to avoid conflict and overlap in work programmes, which should complement each other.

2. PACIFIC ISLANDS: CULTURAL AREAS AND EEZS



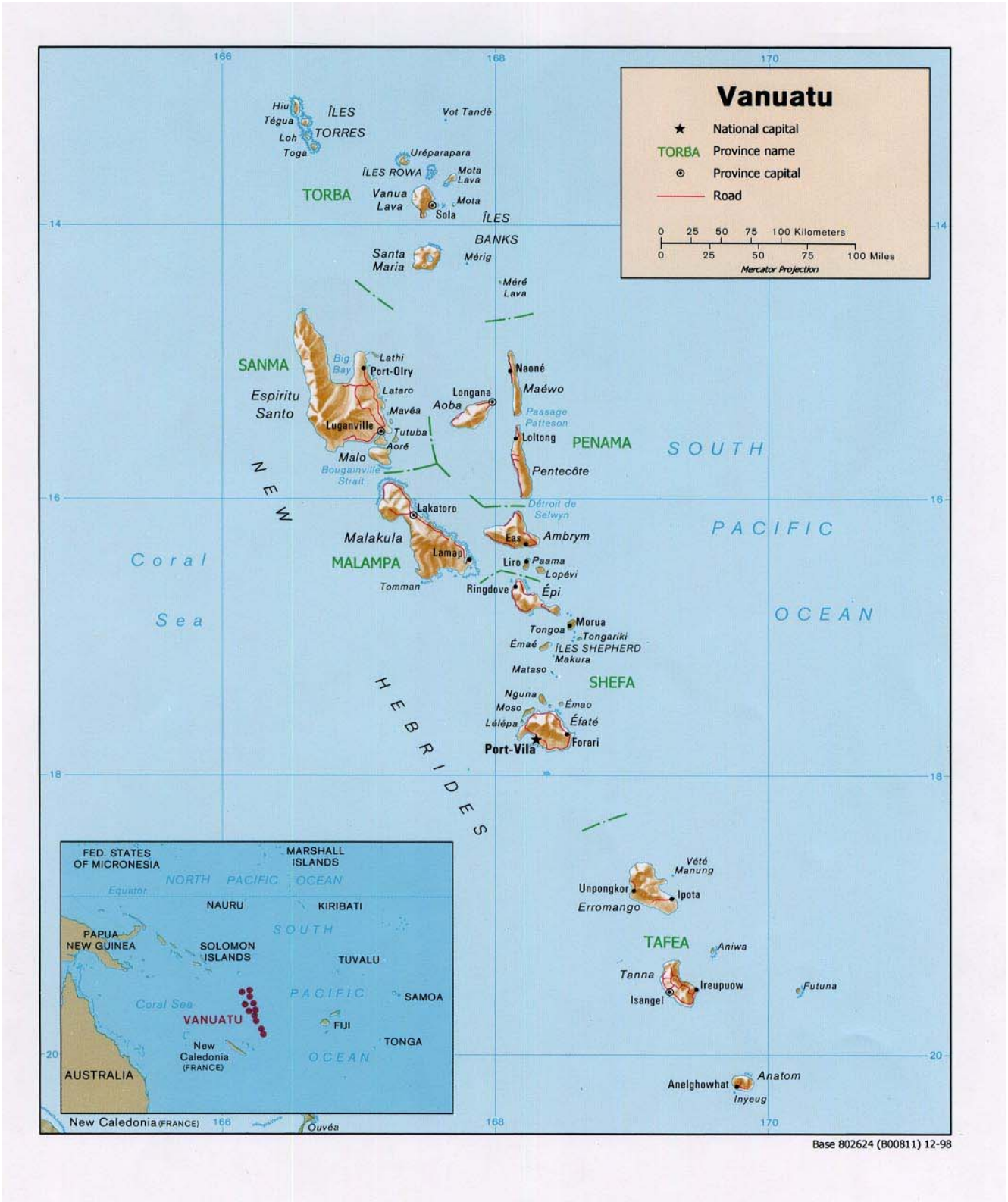
Vanuatu claims sovereignty over Matthew and Hunter islands and a large EEZ around them; however, this claim is disputed by France. A successful claim by Vanuatu will increase the size of the EEZ by 230,000 square kilometers.

It is the stated policy of the government of Vanuatu that the EEZ includes those waters around the islands of Matthew and Hunter. In order to facilitate resource management and remove ambiguity the Vanuatu Government will need to promote rapid and equitable resolution of EEZ boundaries with Fiji, the Solomon Islands, New Caledonia, and France.

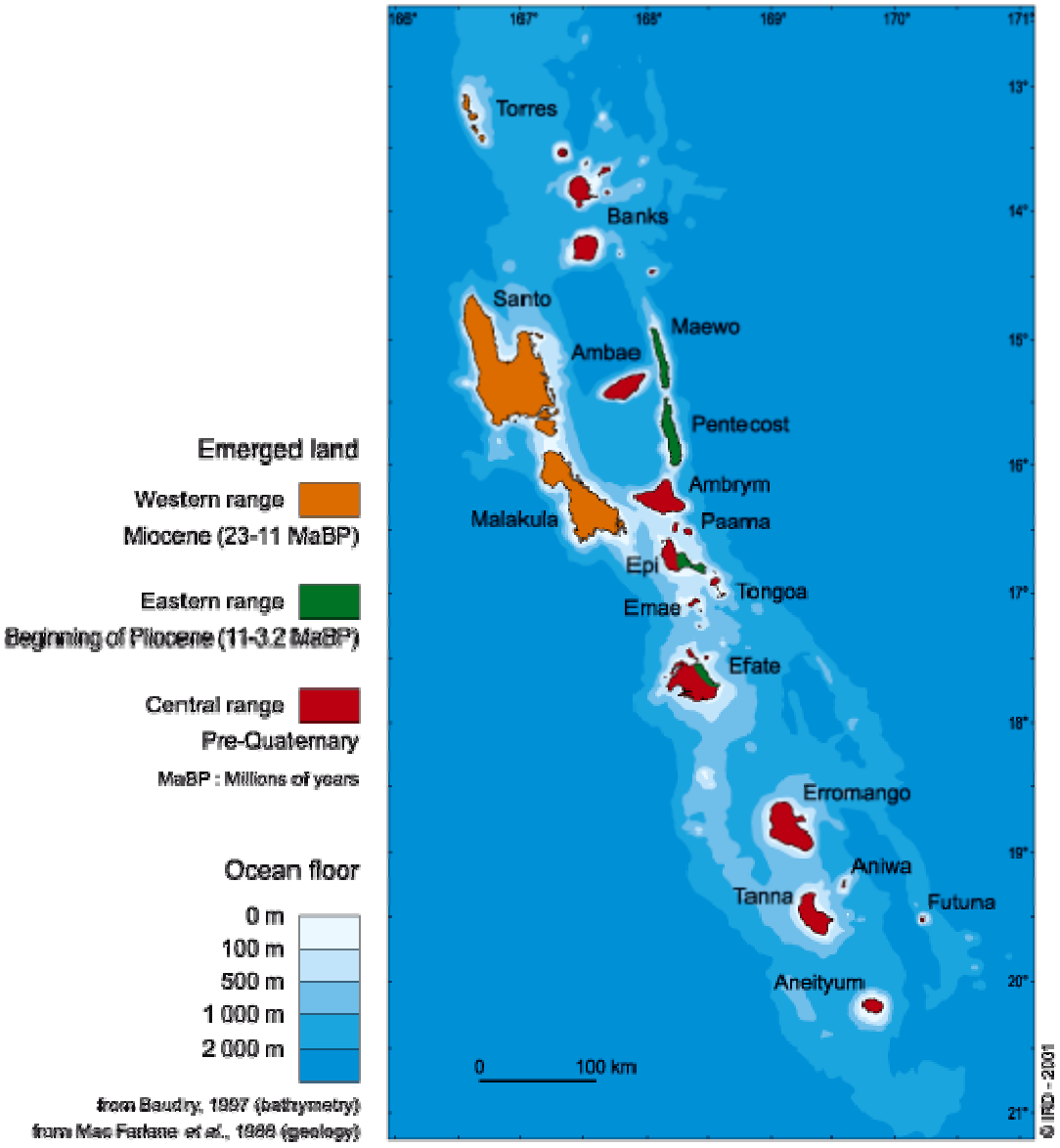
In the short term, prior to resolution of boundaries with its neighbours, it is important for Vanuatu to develop a clear definition of the exact boundaries of the Vanuatu EEZ (including the Matthew and Hunter zone) so that it can be included in license terms and conditions and can be used for management purposes. This may require amendment to the Maritime Zones Act.

Figure 2. Map of Vanuatu showing a portion of the EEZ, and 12 and 24 mile zones

2.1 VANUATU ARCHIPELAGO



3. GEOLOGICAL STRUCTURE AND BATHYMETRY OF THE VANUATU ARCHIPELAGO



Three ridges re-dominate in the geological structure of Vanuatu: an ancient western range (23-11 MaBP), which includes the Torres archipelago, Santo and Malekula; a more recent eastern range (11-3.2 MaBP), with Maewo, Pentecost, and part of Epi and Efate; a recent central range with active volcanoes, which from north to south encompasses the Banks archipelago, Ambae, Ambrym and part of Epi and Efate Islands, along with the Shepherds, Erromango, Tanna and Aneityum archipelago. The upper emerged parts of these ridges (1 000 m and 500 m isobaths) are not continuous, i.e. they are several distinct entities separated by deep channels. The largest includes all of the central and central northern islands of the archipelago–a V formation with Santo at the northwestern point, Maewo the northeastern point, and Efate the base. Generally, the reef slopes of islands located on the eastern and western ridges of the island arc are steeper than the slopes of islands of the central ridge.

4. LITTORAL AND OFFSHORE TOPOGRAPHY

Vanuatu is the emerged part of an island arc, with a narrow rim delineated by a 2 000 m isobath. An area near the coasts is circumscribed by a 500 m isobath. This zone is accessible to small-scale demersal fisheries. No lagoons were formed given to the geological history of the archipelago. The shoreline of the high islands of Vanuatu is generally quite uniform, with few peninsulas and the bays open widely into the ocean, which is not very suitable for ports. Throughout the archipelago, Port Sandwich bay, located on the southeastern point of Malakula Island, is the only inlet along the coast that is wide and deep enough to harbour vessels.

As there are no lagoons and thus barrier reefs, there are only fringing reefs around Vanuatu. They are characterized by reef flats where marine spermatophytes sometimes grow in sandy patches, with the surf breaking on a spyr-rill zone and on an algal crest composed of incrusting algae. This area is generally not more than 100 m wide and the reef is only a few metres thick. Throughout Vanuatu, there is 44 800 ha of fringing reef, and 53% of this reef is along the coasts of Malakula (10 100 ha), Efate (8 070 ha) and Banks-Torres Islands (5 370 ha, excluding Reef Island).Throughout the coastal area, the coral reefs, along with the river mouths and mangroves, are the biotopes with the highest species diversity in terms of fish, crustaceans and shellfish.

Coral structures develop as the result of symbiosis between coral polyps and unicellular photosynthetic algae they harbour in their tissues. These *zooxanthella algae* require light to produce organic matter that is utilized by coral polyps for their growth. Below 50-60 m depth, there is not enough light for photosynthesis and therefore coral madrepores generally do not extend beyond this depth.

View over the reef flat: living (underwater) coral colony (finger coral). The necrosed and emerged peak of this colony was uplifted during the 1965 earthquake

Living coral emerged at low tide

Living coral in a reef crevice

River mouths and mangroves are easily accessible fishing areas. Throughout the country, 288 rivers have a mouth that is large enough to be a fishing zone with a high enough discharge rate to fertilize the coastal zone–half are located in Santo and Malakula Islands, where 63% of the 3 000 ha of mangroves in Vanuatu are also located.

River in southern Efate

Mangrove north of Erakor (Efate)

Mangroves are critical for the coastal environment and native animal species. This ecosystem, which is located at the interface of marine and land environments, acts as a buffer between the violent marine biotope (waves and storm winds) and the invading terrestrial biotope (turbidity). The leaf mass slows down the storm winds, thus protecting the crops and houses located inland. Mangrove root systems (buttress roots and pneumatophores) hamper the erosive impact of waves and promote sedimentation of suspended particles derived from soil erosion that could smother the coral reefs. Mangroves, where there is abundant decomposed matter, represent nutrient-rich environments for sheltered species. The aerial roots, which are emerged at high tide, provide excellent sites for the attachment of molluscs and many small species of algae and benthic microalgae. These roots also harbour juvenile and adult fish and crustaceans taking shelter from oceanic and estuary predators. In addition, the breakdown of organic material enriches the nearby marine environment.

Mangrove pneumatophores at Efate

Mangrove buttress roots

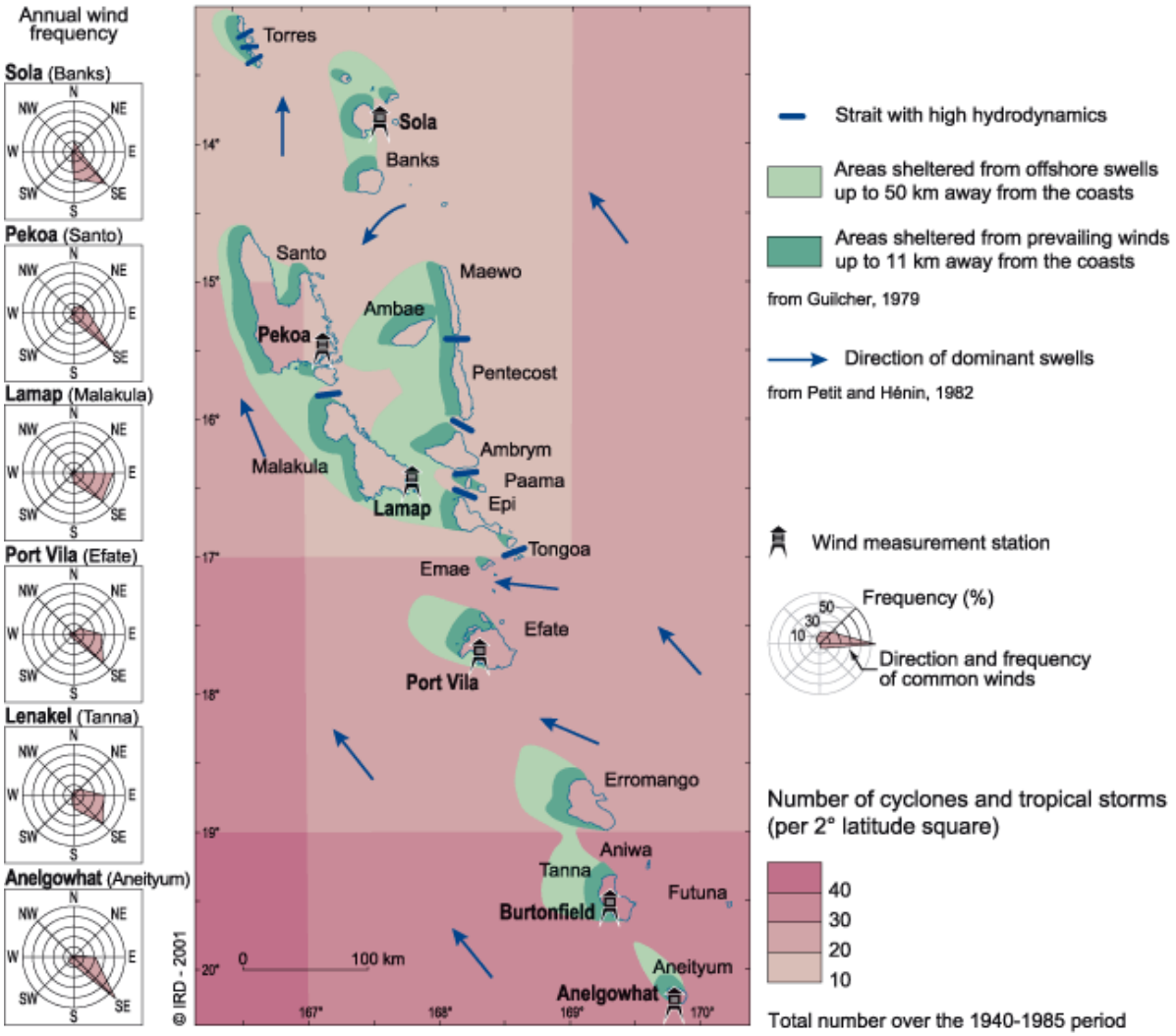
Abundant foliage

Areas covered by reef flats and mangroves on an island, along with the number of river mouths, gives only a partial indication of the importance of these ecosystems with respect to subsistence fisheries development–the ratio of these parameters to the coastline length provides a much better

indicator. In this respect, the following two islands show the highest fishing potential: Aneityum, with 43 ha of reef flats per km of coastline, and Malekula with 4.2 ha of mangroves per km of coastline. Efate and satellite islands form the most uniform group, where the reef index, and the index of mangroves and the number of rivers per km of coastline are higher than the Vanuatu mean. In contrast, the coastal zones of three volcanic islands, i.e. Ambrym, Ambae and Paama (Lopevi), are not very suitable for fishing activities–there are very few reef flats on these recent island, and no mangroves or rivers.

5. THE CLIMATE AND ITS IMPACT ON FISHERIES

A southwesterly trade wind regime prevails throughout most of the year in Vanuatu. The trade winds are easterly in southern and central Vanuatu and southerly in the far north where there is a clear equatorial climatic influence. Hence, in northern Vanuatu, there is a high percentage of periods (mainly in summer) with calm weather and mild breezes.



In Vanua Lava, there is thus a 6-month calm period from November to April, while it is generally only calm during February in Aneityum Island. A latitudinal zonation of the archipelago can be sketched from the south, which is quite windswept and the ocean is often very rough–making it quite impracticable for small boats–to the north, which is less exposed to winds and therefore more suitable for fishing.

Another zonation applies, which is dependent on the extent of exposure to the trade winds. The windward coasts, which are hit with high oceanic waves, are less practicable for fishing than the leeward sides. The sheltered zones, which correspond to boundary fishing and navigating

conditions for the small fishing boats, extend up to 50 km away from the coasts (distance necessary for 15 and 12 knot winds blowing for 5 h to form 0.6 m and 0.9 m high waves, respectively*). The navigational limit under good weather conditions is around 10 km from the coasts (distance required for 10 knot winds blowing for 2 h to form 30-35 cm high waves). Hence, the "leeward sea" between Santo and Malekula Islands to the west and Maewo, Pentecost, Ambrym and Epi Islands to the east is an ideal fishing area that is sheltered from the southeasterly swells. The straits between the islands are characterized by high hydrodynamics, with refracted swells and tidal currents.

Tropical cyclonic phenomena are meteorologically classified as follows: tropical cyclones, characterized by wind speeds of 63 knots or more; severe tropical storms, with winds of 48-63 knots; and tropical storms, with maximum wind speeds of 34-47 knots. From 1940 to 1985, 58 severe tropical storms and cyclones affected Vanuatu, 65% of which occurred in January and February.

Climatically, northern Vanuatu would seem to be the most suitable for fisheries development (milder trade winds, long calm periods, few devastating cyclones). Conversely, southern Vanuatu would be better for setting up infrastructures associated with fish preservation techniques, which require ventilation, and good relative humidity conditions for fish salting and drying

6. BACKGROUND

6.1 THE COUNTRY

Vanuatu was first visited by Europeans in the early 17th century. James Cook explored the islands in 1774, giving them the name "New Hebrides" which lasted until independence on July 30th 1980. The first European settler was a cattle rancher who arrived in 1854. He was soon followed by cotton growers from Australia and later by the French, who outnumbered the British three to one by the mid-1880s.

The Republic of Vanuatu comprises an archipelago of over 80 islands, of which 67 are inhabited and 12 are described as major islands. These islands lie between latitude 13° South and longitude 166° East and 172° East in the western Pacific Ocean. The archipelago measures approximately 850 km in length and lies in the middle of a triangle formed by Fiji, Solomon Islands and New Caledonia. The islands include both volcanic rocks and marine limestone derived from fringing coral reefs. Because of Vanuatu's location on the margin of the Indian and Pacific Plates, tectonic uplift and subsidence of islands periodically occur.

The total land area is 12,200 square kilometers of which 5,500 sq. km (45%) is considered potential arable land. The areas of inner reefs and lagoons have been estimated to be approximately 448 sq. km and mangroves 25 sq. km. The climate varies from tropical in the north to subtropical in the south and annual rainfall ranges from 1700 mm in the south, to almost 3,000 mm in the north. Cyclones are regular, occurring on average twice per year.

The ocean surface currents in the vicinity of Vanuatu are variable in direction and rate, but are moderate as the maximum current velocity is 40 cm per second or 0.75 knots. The westward flowing northern branch of the South Equatorial Current (SECN) is the strongest current in the south Pacific, but does not affect the Vanuatu fishing zone. The westward flowing southern branch of the South Equatorial Current (SECS) is evident to the north of 20°S and appears strongest from July to October. The South Equatorial Countercurrent (SECC) shares a northern boundary with the SECN and a southern boundary with the SECS. The SECC is evident from 5° to 10°S during November to April.

In the Vanuatu EEZ, the ocean surface is warmest (27° - 29°C) during January and February and coolest (24° - 27°C) during July and August. The thermocline, a region where temperatures decrease 27°C to 15°C is from 75 to 350 m in the Vanuatu EEZ. On average, the thermocline in Vanuatu is slightly deeper than in the Solomon Islands. Dissolved oxygen concentrations are generally high in Vanuatu EEZ and should not limit the vertical distribution of tuna. These subsurface oceanographic conditions are likely to influence longline fishing performance, where the thermal and oxygen profile effectively determines the extent of yellowfin and bigeye tuna habitat fished by the longline gear. Both the primary and secondary productivity within oceanic waters near Vanuatu are low to moderate. Though the Vanuatu EEZ has lower productivity than Papua New Guinea or the Solomon Islands, there is high localized production around several islands.

6.2 THE PEOPLE

The indigenous people of Vanuatu or ni-Vanuatu are Melanesian in origin, apart from about 7 – 8% of the population who are immigrants or descendants thereof, from Europe, Asia and countries of the Pacific Islands region. The ni-Vanuatu are culturally heterogeneous, a fact which is reflected in the large number of languages spoken in the country. With over 100 distinct tongues for its relatively small population, Vanuatu is thought to have the highest linguistic diversity of any country in the world. The national language, Bislama, is a form of Pidgin-English. Besides Bislama, the two official languages of Government and the country are English and French.

Between 1989 and 1999 the population of Vanuatu increased by an average of 2.7 percent per annum to 186,678. Eighty percent of the population reside in the rural areas and depend on agriculture for their livelihood, productivity, particularly in the traditional food crops sector, is quite

low. The urban population increased at 4.2 percent, which is considerably faster than the overall rate of increase. The proportion of the population below 15 years is 41.5 percent while those below 25 years constitute 59.3 percent.

Recent population count in 2002 places Vanuatu with a total population of 207,000. This represents an annual growth rate of 2.4%. Calculated population density is 15.3. Average life expectancy is 69 years.

6.3 THE GOVERNMENT

Prior to Independence in 1980, Vanuatu was known as the New Hebrides and had been governed for 74 years by a joint Anglo-French Condominium. The first free and open elections were held in November 1979, after the various political parties and the Condominium powers within the country agreed to a constitution for the Republic. The Independence of the sovereign state of Vanuatu was celebrated on July 30th 1980 and it became the 155th member of the United Nations in September 1981.

Vanuatu's national political structure consists of legislative, executive and judiciary branches. The legislative branch consists of a single chamber, Parliament, with 52 seats. Members of Parliament are elected every four years. The Executive consists of the Prime Minister and the Council of Ministers all of whom are members of Parliament (there are 13 Ministers). The Judiciary consists of a Supreme Court with a Chief Justice and three Judges. The Head of State is the President of the Republic and is elected for a period of five years by an Electoral College consisting of members of Parliament and Presidents of Provincial Governments. There is a National Council of Chiefs which is mainly an advisory body to Government and is composed of custom chiefs elected by their peers sitting in the Island Council of Chiefs. The Council of Chiefs advises on custom and tradition as well as the preservation and promotion of the country's culture and indigenous languages.

The government's capital sources of revenue include grant aid, government collection (e.g. import duties, VAT, licenses, export permits, company registration, land registration, other taxes, public enterprises, interest and rent, fees and fines, etc.) foreign borrowing (soft loans) and direct investment.

6.4 THE ECONOMY

Agriculture accounted for 18% of total GDP in 1999 at constant 1983 prices and 16% at current prices. Self –sufficiency agriculture made up some 51% of the total contribution of agriculture to GDP at both current prices and constant prices. Agriculture, fisheries and forestry combined account for 23% of GDP.

Table 1: Production of Major Commodities, in tonnes

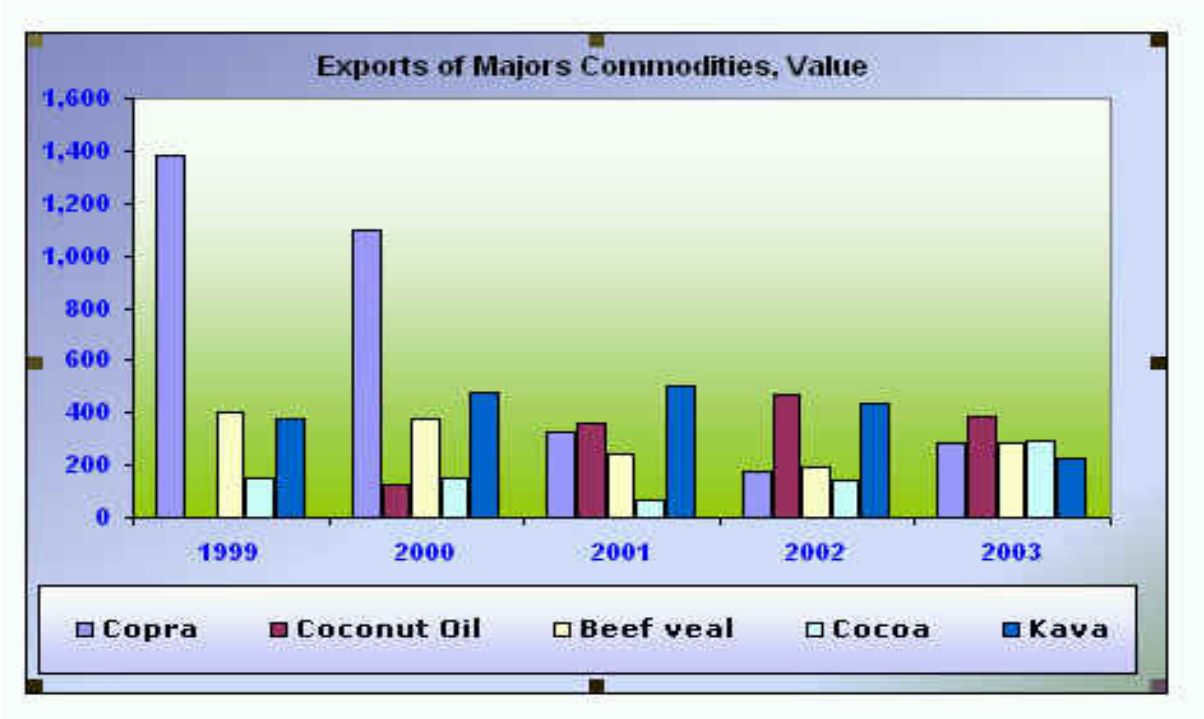
Commodities	1999	2000	2001	2002	2003
Copra	27,723	48,337	14,258	7,338	10,620
Coconut Oil	-	1,812	8,733	9,856	7,725
Beef veal	1,577	1,361	815	685	976
Cocoa	1,104	1,536	538	756	1,506
Shells	85	106	39	19	23
Cowhides	258	347	272	235	289
Kava	334	555	935	456	491
Coffee	10	-	8	81	-

Primary agriculture products, mainly copra, beef, cocoa, coconut oil, cowhides and kava, along with timber and shells, account for the bulk of merchandise exports. Copra is still the largest export earner in value terms.

Table 2: Exports of major commodities, Value

Commodities	1999	2000	2001	2002	2003
Copra	1,381	1,096	323	174	282
Coconut Oil	-	126	362	471	382
Beef veal	404	380	239	194	287
Cocoa	148	147	64	143	295
Shells	76	107	95	50	45
Timber sawn	363	415	334	197	249
Cowhides	27	47	39	28	36
Kava	379	478	503	230	228
Coffee	2	-	5	1	-
Other Products	124	418	338	438	797
Total	**2,904**	**3,214**	**2,302**	**1,928**	**2,600**

Figure 1: Graph showing export value of major commodities from Vanuatu for the years 1999 to 2003



The above graph depicts the annual exports per year per commodity. Since 2001 copra exports have reduced while coconut oil exports have increased. Vanuatu's dependence on a few commodity exports renders the country highly vulnerable to shifts in world commodity prices. The lack of growth in agriculture does not reflect the potential for the sector. About 45% of the total land area in Vanuatu is cultivable, characterized by good quality soils and favorable agro-climate conditions.

Table 3: Total Exports by major countries, Value

Major countries	1999	2000	2001	2002	2003
European Community	1,275	587	187	228	495
Japan	565	387	273	228	248
Australia	80	194	524	621	529
New Caledonia	126	188	125	192	235
South Korea	48	28	38	4	9
New Zealand	56	103	89	72	36
Bangladesh	154	690	199	104	213
Other countries	603	1,036	867	682	835
Total	**2,907**	**3,214**	**2,302**	**2,170**	**2,600**

European Community and Australia have been the mainly importers of manufactured Vanuatu commodities. Vanuatu has experienced serious trade imbalances since independence. The proportion of exports to imports has varied from 20 to 38% over the past decade. The further trade liberalization that will occur under trade agreements such as the MSG Trade Agreement will make it increasingly difficult for Vanuatu to improve or even maintain its current balance of trade, unless new, more effective development strategies are adopted, particularly for the agriculture sector but also for fisheries and forestry

6.5 INSTITUTIONS/AGENCIES

6.5.1 Fisheries Department, Ministry of Agriculture, Quarantine, Forestry and Fisheries

Administration and management of the fisheries sub-sector lies with the Fisheries Department within the Ministry of Agriculture, Quarantine, Forestry and Fisheries. The Department is also tasked with the responsibility to monitor the fishery and to implement development projects.

The Department's headquarters are in Port Vila with a regional office in Luganville and smaller provincial centers in each of the Vanuatu's six provinces. The Department is headed by a Director and has five functional divisions: Research and Aquaculture, Management and Policy, Licensing and Compliance, Development and Capture, and the Administration division.

The overall objectives of policy in the fisheries sector are as follows:

i. to develop the exploitation of fisheries resources to achieve its potential as an important economic activity;
ii. to maximise the sector's contribution to an expansion in the nation's income-earning and employment opportunities;
iii. to increase the production of fish and other marine products for domestic and overseas markets;
iv. to reduce the level of canned and fresh fish imports; and
v. to increase the sector's contribution to government income available to support other areas of social and economic development.

6.5.2 Environment Unit, Ministry of Natural Resources, Energy and Environment

The Environmental Unit is established under the Ministry of Lands, Energy and Rural Water Supply and became operational in September 1986. The Second National Development Plan (1987-1991) (DP2) noted that the proposed work of the Unit was related specifically to the national objective of Preservation of the Cultural and Environmental Heritage. It was the only agency charged with taking overall and cross-sectoral responsibility for environment and conservation and to oversee and coordinate environmental and conservation issues. The Development Plan lists the objectives established as:

- increase study and knowledge of the natural environment and its wildlife resources;

- study and recommend procedures for the rational and wise development of the natural resources and wildlife;
- initiate relevant legislation as necessary;
- increase the awareness of conservation and environment issues in Government and other agencies; and,
- provide technical expertise to Government and other agencies as required.

The establishment of the Unit presented an opportunity to produce legislation and procedures to ensure that considerations for the environment and conservation are adequately covered in the development process. Strategies adopted to obtain objective goals include:

- production of a National Conservation Strategy report which will provide the basis for the rational development of natural resources;
- identification and preparation of environmental legislation and administrative procedures as required;
- organisation of surveys to identify the country's most valuable wildlife and landscape resources;
- promotion of cross-sectoral discussions and information exchange between Government and other agencies concerned with environment issues;
- promotion of environmental education amongst government personnel and the country as a whole;
- development of contacts and co-operation with international environment agencies;
- recruitment and training of ni-Vanuatu to participate in, and then take over and develop, the above strategies.

In the Third National Development Plan (DP3) (1992-1996) the Environment Unit is listed as been "responsible for the coordination of all activities across sectors, Government agencies, NGOs and the private sector that deal with environmental matters; it also provides technical advice and specialist attention on environmental matters" (National Planning and Statistics Office, undated). Development objectives during the DP3 period are listed as:

- complete environmental legislation and formulate an environment master plan to guide future development activities;
- review the organisational structure of the Environment Unit with the view of upgrading its status to a full Department to monitor environmental changes, enforcing environmental legislation, continuing environmental awareness and educational programmes and continuing of Vanuatu's active participation in global environmental issues;
- prioritize environmental problems and ensure that scarce financial resources are committed to priority areas;
- provide community extension programmes that assist individuals to see the importance of a healthy environment and enable community leaders and land owners to establish their own policies of land use, resource protection and sustainable development.

6.6. MANAGEMENT OF FISHERIES RESOURCES

Management of fisheries in Vanuatu, as elsewhere, is understood to mean the exercise, by some authority, of control over access to fishery resources that ultimately limits, redistributes or otherwise modifies the type or amount of fish or seafood being caught, and thus the economic or other returns deriving from it.

Fishery management in Vanuatu is based on a number legal instruments which:

i. Establish a wide range of national-level rules and regulations governing, inter alia, foreign access, vessel licensing, Vanuatu participation in international agreements, prohibited fishing methods, size limits, exports licensing, marine reserves, and the deployment and use of fish aggregation devices;
ii. Empowered Provincial Government Councils to pass by-laws making “rules and regulations governing fishing and conditions relating to the issuing of fishing licenses covering six nautical miles as from the low tide foreshore of all islands making up the Provincial regions”;

iii. Uphold the principles of customary marine tenure, whereby customary landowners also own the foreshore and fringing reefs and the resources they contain.

The Department of Fisheries, Ministry of Agriculture, Quarantine, Forestry and Fisheries, is responsible for the control, development and management of the fisheries resources. The main piece of legislation dealing directly with the management of inshore fisheries is the Fisheries Act 1982 [CAP. 158], and subsequent amendments. Other relevant instruments include the Decentralization and Local Government Regions Act (1994), laws relating to the issue of Business Licenses (CAP 173), the Maritime zones Act (1981) and various Land laws. Vanuatu is also a party nation to a number of international conventions and treaties, including the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the United Nations Convention on the Law of the Sea (UNCLOS)

6.7 CUSTOMARY MARINE TENURE

Customary marine tenure (CMT) is the general term given to the various systems of ownership or control of marine spaces or the resources they contain by indigenous tribes, clans or communities. CMT has been traditionally practiced in most Pacific Island countries and continues to exist in various forms throughout the region.

There is no single body of custom in relation to marine tenure in Vanuatu; there are over 100 different village language groups with differing resource tenure customs. In many places land and sea tenure rights are inherited through men, but in some it passes down through women. CMT not only survives throughout Vanuatu, but is going through a period where exercising the right to exclude outsiders and regulate one's own groups' activities on the fishing ground is intensifying.

Ownership of marine resources creates opportunities not only for resource management, but also for dispute. Considerable population movement in Vanuatu over the past century was associated with coastal land alienation for plantations etc. and by churches for their settlements. Since custom laws were never written down, this has resulted in poorly remembered histories of traditional ownership of land and associated fishing grounds in some areas. Sometimes a request for identification of custom owners can stir up old disputes that have been sleeping for many years, or the desire for money can lead to claims, which have little foundation in true custom.

In Vanuatu, as in many Pacific island countries, land tenure is the most contentious and widespread legal issue. In formally identifying custom owners and determining their traditional rights, the government therefore gives priority to land that is the subject of dealings under law (for example, leases, logging contracts, declarations of public land). The legal framework for dealing with these problems remains inadequate. And since nearshore marine resources have seldom been subject to such dealings, the development of formal government procedures for dealing with CMT has lagged behind those dealing with land tenure.

Vanuatu's various land laws provide for customary ownership of land based on the concept that all land in Vanuatu is the inalienable property of the ni-Vanuatu people. This concept is enshrined in the Constitution, which states (Chapter 12, Article 71) that, "*all land in the Republic belongs to the indigenous custom owners and their descendants*". And "land" includes "land extending to the seaside of any foreshore reef but no further" under the Land Reform Act (Cap. 123). The government laws concerning land in Vanuatu often pertain to tenured marine areas. Land Leases Act stipulates that customary owners cannot lease their reefs as they can with their land.

Customary ownership of land extends to the outer limits of coastal or fringing reefs. The marine resources in these areas are essentially the property of the landowners who may exploit or restrict access to them as they see fit. Resources such as trochus, green snail and beche-de-mer, which are found and exploited principally in shallow inshore waters, are thus particularly affected by customary marine tenure practices.

One of the virtues of customary tenure is its flexibility. Allowances are made. For example, for circumstances such as adoption or settlement in the community of people from elsewhere, or formulation and implementation of different marine resource management mechanisms. This flexibility is apparent today in Vanuatu particularly in the changes in village marine resource management practices as these resources take on increasing monetary significance. When such

local customs and laws are precisely defines and fixed legally they tend to freeze tradition, leaving villagers less flexible in their responses to demographic changes, changes in technology, or other developments that require adjustments in local resource use patterns and controls.

The numerous and various rules of custom that permeated all aspects of island life combined to form a multi-dimensional lattice that provided a blueprint to life on the islands - and thus to the management of resources - as well as other aspects of life like contributing to birth control as well as minimizing conflict and maintaining harmony within the clan by determining social relationships. These 'blueprints', encoded and enshrined in custom were derived from the ancient gods and cultural heroes and sanctioned by the ancestors as 'the way' and passed on to the next generation through the oral traditions of the islands.

There were formerly a number of different traditional marine management measures practiced in Vanuatu. These practices varied amongst the numerous different cultural groups found throughout these islands, and reflect this cultural diversity. Some of these practices are still found today, others have survived only through oral history.

Examples of some of the cultural practices can be found throughout different areas of Vanuatu which resulted in a taboo being placed on a reef and thereby allowing reef resources to rest and recover for varying lengths of time. In most cases, taboo leaves specific to the cultural group are erected to indicate clearly the area covered by the taboo.

Vanuatu's experience suggests some strategies and conditions that would favour the success of government-supported, village-based management of small scale fisheries in other Pacific islands. These include:

1. Publicize in coastal communities the government's willingness to collaborate with villagers on management issues, and invite requests for assistance from interested villages.
2. Start small, not with a comprehensive plan to address many types of fisheries or many villages.
3. Concentrate initially on villages where local marine tenure an local authority are strong and the community is cohesive.
4. Concentrate initially on villages where fishing ground geography facilitates effective village surveillance

6.8 MARINE RESOURCES LEGISLATION

6.8.1 Constitution of the Republic of Vanuatu

The 1980 Constitution touches on natural resources or the environment. It imposes for every ni—Vanuatu a fundamental duty to himself and his descendants and to others "to protect the Republic of Vanuatu and to safeguard the national wealth, resources and environment in the interests of the present generation and future generations".

6.8.2 Maritime Zones Act 1981 [CAP. 138].

The Maritime Zones Act (1981) establishes a series of archipelagic baselines around the islands of Vanuatu and uses them as a basis for the definition of a territorial sea and other maritime zones, as follows:

- **Internal waters:**

Essentially rivers, lakes and the intertidal zone down to the low-water mark, as well as the interior parts of bays and other semi-enclosed waters;

- **Archipelagic waters:**

Comprise all waters inside the archipelagic baselines, other than internal waters;

- **Territorial sea:**

Comprises all waters outside the archipelagic baselines, up to a limit of 12 nautical miles;

- **Contiguous zone:**

Waters outside the archipelagic baselines, up to a limit of 12 nautical miles, but excluding the territorial sea;

- **Continental shelf:**

Comprises the seabed and subsoil of the submarine areas that extend beyond the limits of the territorial waters throughout the natural prolongation of the land territory to the outer edge of the continental margin or to a distance of 200 nautical miles from the baseline from which the territorial sea is measured where the outer edge of the continental shelf does not extend up to that distance.

- **Exclusive Economic Zone:**

Comprises areas of the sea, seabed, and subsoil that are beyond and adjacent to the territorial sea measured 200 nautical miles from the baseline.

The main relevance of the Maritime Zones Act to inshore fishery management is the fact that foreign fishing vessels are normally not licensed to fish inside archipelagic or internal waters.

6.8.3 Fisheries Act 1982 [CAP. 158] (currently under review)

Although passed by Parliament in 1982, the Act only took effect in 1983, at which time the Fisheries Act No. 22 of 1983 also annulled certain pre-existing status relating to fishery management. Subsequently the Fisheries (Amendment) Act No. 2 of 1989 made additional provisions, mainly to facilitate the adoption of regional fisheries treaties by the Vanuatu Government. Other minor amendments, additional regulations, and ministerial guidelines have also been issued from time to time.

The Fisheries Act of 1983 (Revised Edition 1988) provides "for the control, development and management of fisheries and matters incidental thereto" and empowers the Minister responsible for Fisheries to make a wide range of judgements and decisions relating to the issue of fishery licenses, fishery conservation and management measures, etc., as well as to grant exemptions from many of the provisions and regulations contained in the Act.

Section II of the Act deals with the Management of Fisheries with the following subsections:

i. Fisheries Management and Development Plans
ii. Fishery Access Agreement
iii. Foreign Fishing Licenses
iv. Minister's Power to Enter into Agreements or Arrangements on Harmonisation of Licensing and Enforcement
v. Regional Register of Foreign Fishing Vessels
vi. Foreign Investment in Fisheries
vii. Local Fishing Vessel Licences
viii. Minister's Power to Authorise Scientific Research Operations.
ix. Application for Fishing Licence
x. Minister's Powers to Refuse to Issue or Renew Fishing Licences
xi. Conditions of fishing Licences
xii. Fees, Royalties and Other Charges
xiii. Period of Validity of Fishing Licences
xiv. Suspension and Cancellation of Fishing Licences
xv. Appeals Against Refusal to Issue or Renew, Suspension and Cancellation of fishing Licences
xvi. Fishing for Marine Mammals Prohibited in Vanuatu Waters
xvii. Prohibition of Use of Explosives and Poisons for Fishing
xviii. Marine Reserves
xix. Licensing of Fish Export Processing Establishments

Section IV, Paragraph 24 of the same Act, empowers the Minister to make regulations to be consistent with the Act for the implementation of its purpose and provisions.

6.8.3.1 Fisheries Regulations Order No. 49 of 1983

The Fisheries Regulations provide for the conservation and regulation of fisheries in Vanuatu waters and the issue of licences. The regulations concerning individual fisheries resources are stated more fully under their respective profile.

Part I - Foreign Fishing Licenses
Part II - Local Fishing Licenses
Part III - Fish Export Processing Establishment Licences
Part IV - Fishery Conservation Measures
- *Rock Lobsters*
- *Slipper Lobsters*
- *Coconut Crab (Coconut Crabs (Protection) Act)*
- *Green Snail*
- *Trochus*
- *Trumpet Shell*
- *Coral*
- *Aquarium Fish*
- *Turtles*
- *Crustaceans*
- *Beche-de-mer*

Part V - Fish Aggregating Devices
Part VI - Miscellaneous Provisions

6.8.4 Foreshore Development Act [CAP. 90]

The Foreshore development Act No. 31 of 1975 regulates the carrying out of works on the foreshore. The Act is administered by the Minister for Internal Affairs thus any development work in this area requires the written consent of the Minister for town and country planning. The foreshore is defined as the land below mean high water mark and the bed of the sea within the territorial waters including lagoons.

Until early 2003 there were no statutory requirements for EIA's to be submitted prior to any Ministerial consent for development on the foreshore. The Environment Management and Conservations Act, subjects all such developments to mandatory EIA's unless such activity is exempt under the Act.

6.8.5 Environment Act

Government policy on environment and conservation is to provide an affordable framework of environmental protection and compliance within Vanuatu. This is realized through the enactment of the Environment Management and Conservation Act No. 12 of 2002. This commenced as law on 09 March 2003. This is the only legislation governing environmental protection of all natural resources in Vanuatu. It requires mandatory Environment Impact Assessments carried out for all developments that affect the environment before any local or national authority gives consent to developers and project proponents.

The Act sets up a Bioprospecting Advisory Committee, which vets all applications to carry out bioprospecting activities in Vanuatu. The Act is currently implemented by the Vanuatu Environment Unit (VEU), although a Director of Enviornment is not yet appointed.

6.8.6 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

Vanuatu became a party nation to CITES on 15 October, 1989. Trade in species listed on Appendix 1 of the CITES treaty is prohibited, while trade in those species listed on appendix 2 requires the authorization of the appropriate national authority which, in Vanuatu's case, is the Environment Unit of the Ministry of Lands and Natural Resources. Marine species currently listed on Appendix 2 of CITES include all six species of giant clam thought to be present in Vanuatu, as well as corals.

6.8.7 Decentralization Act

The Decentralization and local Government Act of November 1994 replaced the earlier Decentralization Act (CAP 127) with a new instrument, which gives more extensive powers and authorities to Local Government Councils (LGCs) in six newly-defined provinces within Vanuatu. LGCs are also referred to as Provincial Governments.

The significant of this Act for inshore fisheries management is the extensive powers it conveys to the LGCs to pass by-laws affecting marine resources use. The Act entitles LGCs to pass by-laws consistent with existing legislation in order to make "rules and regulations governing fishing and conditions relating to the issuing of fishing licenses covering six nautical miles as from the low tide foreshore of all islands making up the LGC region". The LGCs are also empowered to pass by-laws in relational to local economic development policies and plans, environmental protections zones, business licensing, infrastructure development and various other issues that may impact on marine resource development.

7. DEVELOPMENT PLANS

The First National Development Plan covered the period 1982-1986. This was mostly a period of reconstruction and transition with the primary objectives being diversification, strengthening and expansion of productive economic base especially the reduction of dependence on copra. Natural resource-based major projects were initiated. These include the establishment of cocoa and coffee projects, copra rehabilitation programme, village-based fisheries programme and the expansion of tourism infrastructure.

The broad focus of the Second National Development Plan (1987-1991) shifted to sustaining and enhancing achievements made in DP1 through greater emphasis on manpower development and improved management (DP2). Thus DP2 national development objectives were to:

- achieve an increased degree of economic self-reliance based on natural resource development compatible with appropriate and acceptable levels of service provision;
- accelerate human resource development for increased ni-Vanuatu participation in, and control of, the economy;
- increase productive utilisation of the country's natural resources base as a means of generating viable and sustained economic growth;
- achieve a more even pattern of regional and rural development;
- further expand the private sector's contribution to national development efforts for the benefit of the whole country;
- ensure that Vanuatu's unique environmental and cultural heritage is not damaged in the process of economic development and change; and
- ensure continuation of a stable political environment, based on parliamentary democracy.

The implementation of these objectives were adopted under the following five broad strategies:

- the decentralisation of administration, executive and some implementation functions to the Local Government Councils;

- the active promotion of both the small holder and the large commercial plantation agricultural sub-sectors;
- the continued promotion of new domestic and foreign investment in the leading sectors of the economy, particularly tourism, and the processing of primary produce;
- the development of human resources through on-the-job training, improving the quality of primary and secondary school education, and post-secondary education in scientific and technical fields;
- the establishment and operation of an integrated project planning, capital budgeting, manpower planning system and environmental impact assessment methodology, designed in order that: investment resources are channelled into priority sectors; the recurrent cost implications are fully appraised prior to implementation of capital projects and consolidated into the integrated capital and recurrent budget; the necessary manpower is either available or appropriate training programmes are devised; and adverse environment impacts are minimised.

Within the Fisheries Sector, the emphasis of development during the DP2 period was on activities with the greatest potential to generate or sustain income-earning opportunities and employment to stabilise or reduce imports, to expand exports and to increase government revenue.

The Developmental Strategies for the fisheries sector are listed under six sectors as follows:

Subsistence Fisheries

- Conserve inshore fisheries resources to ensure their continued availability as food for the rural population.

Small-scale Commercial (Coastal) Fisheries

- Continue to assist the formation of small-scale coastal fishing enterprises throughout the archipelago;
- Ensure the long-term viability of such fishing enterprises;
- Produce sufficient fresh fish to satisfy local demand;
- Improve local distribution, storage and marketing facilities;
- Develop export markets and create the necessary infrastructure to support the sale overseas of catches surplus to local demand; and
- Develop local canned fish products to substitute for imported canned mackerel and sardines.

Oceanic Fisheries

- Begin development of a small locally-based ocean tuna fishery;
- Encourage the revival and diversification of operations of the South Pacific Fishing Company (SPFC); and
- Encourage and consider requests for fishing rights within Vanuatu's EEZ from any foreign nation that is prepared to pay the appropriate fees.

Aquaculture

- Conduct pilot trials to test the feasibility of the artificial culture of aquatic organisms and the re-seeding of over-exploited areas of reef.

Research

- Provide the support necessary for the management and sustained economic development of the sector,
- Continuously monitor the availability of fisheries resources and the effects of fishing upon them;
- Develop improved techniques for the harvesting of the sector's resources; and
- Provide the scientific basis for aquacultural development.

Administration, Training and other Departmental Support Activities

- Develop a cadre of qualified personnel within a Fisheries Development & Capture Division able to meet the needs of the expanded fisheries sector;
- Upgrade the training facilities for fishermen and departmental staff;
- Improve the capability of local staff to monitor economic and biological changes within the sector; and
- Improve and consolidate boat-building, marketing and gear supply support facilities provided to the industry.

A policy to concentrate efforts on small-scale fisheries and thus protecting the limited resources has been established by the Fisheries Department as the goal.

7.1 Tuna Management Plan

In 2000, the Department of Fisheries developed a National Tuna Management Plan. The plan sets out the procedures for developing the Domestic Tuna Industry. The Tuna Management Plan was developed to meet four key objectives:

- To ensure that the exploitation of the tuna resources that are found in and pass through Vanuatu waters is compatible with the sustainability of the stocks throughout their range.
- Within the limits of the sustainability objective, to ensure the harvest is taken in a way that maximizes the long term economic and social benefits received by the peoples of Vanuatu.
- To contribute to the food security of ni-Vanuatu.
- To meet regional and international responsibilities for tuna management.

The scope of the Tuna Management Plan covers all highly migratory tuna species including:

- Albacore tuna,
- Yellowfin tuna,
- Bigeye tuna,
- Skipjack, and
- All other species taken in the course of fishing for tuna.

The Tuna Management Plan covers all Vanuatu waters including the consideration of the area of the Vanuatu EEZ around Mathew and Hunter Islands and Vanuatu flagged tuna fishing vessels wherever they fish.

8. FISHERIES SECTOR OVER VIEW

As a signatory to the United Nations Commission on the Law of the Sea (UNCLOS), Vanuatu claims sovereignty over a 200 n mi EEZ, enclosing some 710,000 square kilometers of ocean. The fisheries sector of Vanuatu is an important provider of employment, food and income generation, and development of import substitution of food stuffs. Fisheries resources are exploited at the subsistence, artisanal and industrial levels. As is the case in many Pacific Island

States, fish resources provide the principal source of animal protein for ni-Vanuatu communities, especially those living throughout the many scattered islands of the country.

The fisheries resources of Vanuatu are made up of three main components. These include the various species of tuna, the deepwater bottom fish generically referred to as “poulet”, made up of primarily of snapper and related species, and the reef fish that inhabit the coastal waters inside the reefs. Current fishing activities in Vanuatu can be classified into the following broad categories:

i. Subsistence sector – near-shore reef fishing for subsistence purposes, targeting reef associated and lagoon fish and shellfish and small pelagics; also reef gleaning, shell collecting;
ii. Artisanal sector – small-scale commercial fishing principally targeting shallow and deep-water bottom snapper (poulet) species and FAD associated pelagics using trolling and longlining techniques. Also collection of sessile organisms such as trochus, green snails, beche-de-mer, etc;
iii. Big game/sports fishing – commercial charter boat sport fishing for tourists, targeting billfish, tunas and large coastal pelagic species. Some vertical droplining for deep-water bottom fishes also undertaken;
iv. Locally-based longliners – pelagic longlining for albacore and yellowfin, plus some bottom set longlining for snappers and groupers; and,
v. Foreign access industrial fishing using longline mostly, some multilateral purse seining.

Subsistence fishing is an important aspect of village life and is second only to agriculture. Annual catches of fish and shell fish from reefs and lagoons were estimated at around 1360 t/year in 1983, 93% of which was for subsistence consumption. Estimates of fish production and consumption patterns, and the importance of the near-shore fishing activities to the lives of rural people and the national economy in Vanuatu are not reliable.

Traditional management practices have been used to conserve stocks, although with advances in fishing techniques and equipment, and increasing pressure for financial rewards from fishing, customary methods of fishing have declined in some areas however, in other communities village level management methods are reportedly making a comeback.

Commercial fisheries are centered around the exploitation of high value tuna and deep-water bottom fish. Such fisheries currently make a small but important contribution to national income and to the generation of other socio-economic benefits. Demand for fish in urban centers such as Port Vila and Luganville have grown strongly in recent years.The off-shore oceanic fish resources are considered modest in comparison to other Island States of the western and central Pacific. Tuna, in particular, tend to be highly seasonal in their availability, and are presently lightly exploited.

9 FISHERIES RESOURCES PROFILES

10 CRUSTACEANS

10.1 COCONUT CRAB

10.1.1 The Resource

Species present:
The Coconut or robber crab, *Birgus latro.*

10.1.2 Distribution

Coconut or robber crab is widely distributed from the Seychelles in the Western Indian Ocean to the Tuamotu Archipelago in the Eastern Pacific. Its occurrence is restricted to island habitats and is virtually unknown in East Africa, the Indian sub-continent, mainland Asia and Australia probably due to the presence of large animal competitors and predators in these areas (Brown et al., 1991). However, several reports seem to indicate that the species' range appears to have somewhat diminished. Within certain localities, habitats destruction, uncontrolled exploitation and depredation by domestic and feral animals, have contributed to the declines and local extinctions.

Within Vanuatu, coconut crabs are distributed over a wide area and are present on most islands of the archipelago. The areas of main populations for exploitation at present are in the north, mainly, Banks/Torres, Santo/Malo, and Maewo; and in the south, mainly, Erromango island.

10.1.3 Biology and Ecology

Coconut crab is a "close relative of the hermit crab group and has evolved to become the largest and least marine-dependent of the land crabs" (Brown *et al.*, 1991). It is an omnivorous scavenger and its primary foods include coconut flesh, fruits of the screw-pine (*Pandanus*), *Canarium spp*., sago palm, *Terminalia, Barringtonia*, and *Artocarpus*. Coconut crabs are slow-growing and for the Vanuatu stocks, they take at least ten years to reach legal marketable size (9.0 cm, CTL=43 mm)[2]. Fletcher *et al* (1991) estimated longevity to be between 40 and 60 years and the asymptotic thoracic length of 80 mm and 50 mm for males and females respectively. Growth in coconut crabs, as in other crustaceans, has two components, the increment of growth at each moult and the time interval between each moult episode (Fletcher *et al*, 1991). Moulting is normally once a year with the exception of smaller-sized crabs that are believed to be able to moult more than once a year. For protection from predation and to minimize the risk of dehydration the crabs burrow or hide in small crevices that provide the same conditions as burrows, prior to moulting. The ecdysis process takes from one to two hours to complete while the time between moulting and emergence from the burrows is about one month for small crabs and up to three months for the larger individuals (Fletcher *et al*., 1991).

Mature crabs mate on land in summer while both sexes are in hard shell condition. However, fertilization may require seawater. Laying of eggs is assumed to take place soon after copulation as females do not possess seminal receptacles. The females carry fertilized eggs attached to their pleopods for approximately one month, while maturing, before migrating to the sea for their release. The release of eggs is accomplished using one of the four methods which are closely associated with the type of coastline present.

[2] [CTL=Cephalothoracic length, TL=thoracic length]

(i) In cliff coastlines with narrow or no inter-tidal shelf, the berried crab climbs over the cliff edge and reorients itself so that it faces up the cliff. It then "slowly reverses down the cliff until a wet section, or wave splash, is encountered" at which point it "stops and flexes its abdomen away from the cliff face, letting the egg-bearing pleopods dangle loosely, thus exposing its entire egg mass". The crab moves further down if there is not sufficient splashes at any particular height until it is washed over by a wave which results in rapid hatching of the mature eggs and washing away of the newly eclosed zoea larvae.

(ii) In coastlines with inter-tidal shelf, the berried female walks rapidly across the shelf until it encounters a saltwater pool. It raises its abdomen to keep the egg mass clear of the water and only lowers it into the water with rapid backwards and forwards flexes of its abdomen in small rapid jerking movements, to facilitate eclosion of the eggs, when a wave swamps over it.

(iii) The third method involves coastlines as that in method (ii) above but the release is not through a pool splashed by waves but a saltwater 'steam' draining the shelf.

(iv) The method used in coastlines having a sand or coral rubble beach is similar to that in method (ii) above. The crab moves down the beach into the water until it is swamped by a wave. "In each method, egg hatching/larval release is invoked by exposure of the eggs to moving water, usually via inundation by waves".

Mature eggs hatch immediately into the first zoea stage upon release into the ocean. The hatched eggs undergo four plantonic zoeal stages in approximately three weeks and the crabs (new recruits) emerge from the water as glaucothoe inhibiting shells. The glaucothoe inhabit the wrack area above the high sea mark and are hard to find and be distinguished from other related coenobinids (Reese, 1987). "The glaucothoe subsequently metamorphose into juvenile crabs which maintain the shell carrying habit for one to two years" (Brown, 1988).

10.1.4 The Fishery

10.1.4.1 Utilization

Because of its large size, terrestrial habit and delicate flavour of its flesh, *Birgus* is considered highly as a food item. Coconut crabs are a vital resource for many small communities in Vanuatu, for both commercial and subsistence purposes. The collection and sale of these crabs is sometimes the only form of cash-crop available for the inhabitants of some of the remote islands.



"Coconut crabs are readily captured using methods which require no capital investment in equipment. In most cases they are caught by hand, having first been attracted to a staked bait, often a split coconut" (Brown *et al.,* 1991). The methods have evolved as a result of the declining numbers. For example, in the Torres region, the bait originally used involved entire coconuts with only a small circular hole cut in the inside and which were usually set only an hour before dark and checked shortly after dark. "If the coconuts were opened entirely or left for any longer period the larger number of crabs would have either taken the bait entirely or consumed most of the coconut flesh. Usually the coconuts are split into two and three pieces and baits are not re-visited until after 11 pm to allow a long period of time for the big crabs to come out" (Fletcher, 1992).

10.1.4.2 Production and Marketing

Coconut crab forms the only major potential cash crop for such remote areas as Torres Island, due to the drastic drop in prices of agricultural products especially copra. Ninety-five percent of the total crab production in Vanuatu originates from Santo and Banks/Torres regions.

The crabs are exported to the Vila and Santo urban markets targeting the hotels and restaurants.

A smaller portion came directly from the collectors on those islands. The level of exploitation both for subsistence use and commercial sales for the whole of Vanuatu is unknown. Production data collected by Fisheries Department is scarce and only dates back to 1983.

Table 4: The total estimated production for Santo and Torres regions from 1983 – 1990.

Years	Santo	Banks/Torres - Hiu & Tegua
1983 – 1984	705 kg	4,662 kg
1987	37,600 crabs	122,000 crabs
1988	3,261.5 kg	-
1989	3,493.6 kg	-
1990	1,521.2 kg	-
1991	8, 854 crabs	97,440

In 1991, an estimated 12,000 – 15,000 crabs, mostly originated from either Santo and/or Torres regions were sold at the Vila restaurants. In 1992, an estimated 20,000 crabs equivalent to a total weight 25,600 kg were harvested in Torres mainly from Hiu and Tegua islands and only a small percentage from Loh and Toga islands; while 5,960 crabs, equivalent to a total weight of 4,836 kg were harvested in Santo.

During the 2001 – 2002 harvest season, a total number of 1,797 crabs (3, 181 kg) valued at VT1,636,200 were harvested in Torres and a 2,000 crabs in Santo/Malo region. The crabs are sold at VT850 per kilogram. This compares to an average price of 500-600VT back in 1991. In the open municipal markets in Santo and Vila, the crabs are sold for VT500 to VT2,500 per crab. The actual value paid to the crab collectors vary depending upon whether they sell direct to the restaurants or through a wholesaler, plus the reductions that occur due to the costs of airfreight.

Given these limitations, it is likely that most collectors will be getting less than VT500 and some only VT400 kilo. This is not substantially more than they were receiving 10 years ago at VT350 per kilo.

The total number of crabs purchased by restaurants in Vila is estimated to be approximately 1500 per month, which equates to 18,000 per year. In Santo, there were 2000 crabs sold locally. This makes a grand total of 20,000 crabs sold per year, which is only slightly less than the 25,000 estimated in 1991.

10.1.5 Status of Stocks

The expanding tourist industry and the decline in local copra-based economies has resulted in a significant increase in the socio-economic value of the coconut crab leading to increase exploitative pressures on the local coconut crab populations. Substantial reductions in population size have been noted. The collection and sale of these crabs is sometimes the only form of cash-crop available in many remote regions making the conservation of this resource of paramount importance. This need was highlighted in the ACIAR and AIDAB funded studies conducted between 1985 and 1992. The studies revealed that the crabs had a slow growth rate, recruitment of juveniles may not be large and that the numbers of adult crabs in an area could be reduced very

quickly. At the conclusion of these initial projects, a series of recommendations were provided for the Vanuatu Government to assist with the development of a management strategy to protect the remaining stocks of crabs. This resulted in a set of management restrictions being imposed in July 1991, which included the use of closed seasons and restriction on the number of crabs that could be taken each year from the key areas (i.e. Santo and Torres regions). These controls were in addition to the minimum legal size and protection of berried crabs that had been in force since 1983, but had been ineffective in halting the decline in crab stocks. In many areas, stocks were suffering from growth over fishing and potentially recruitment over fishing.

Given the seriousness of the status of the crab stocks, in 2003 ACIAR funded another study to re-examine the stocks of coconut crabs in Vanuatu to determine if the management arrangements introduced 10 years ago have been sufficient to conserve the remaining stocks. The status of the coconut crab stocks were assessed by field sampling, which utilized the same methods as detailed in Fletcher & Moses (1994). The results of the 2003 stock assessment surveys are as follows:

10.1.5.1 Sanma Province

Overall, the number of crabs found in the 2003 surveys in the Sanma province was similar to or lower than during the last survey period in 1991/93 (Table 2). Some of the Sanma sites had more crabs (Matantas, Thion), others had similar numbers (Hog Harbour) but some had substantially less crabs (Kole). Most of the sites had catch rates less than 0.5 crabs per bait with few legal sized crabs (CPUE<0.15). Thus most areas can be classed as growth over-fished and the entire province is rated as over fished and therefore the total quota should not increase beyond the current official quota of 2000 crabs per year.

Table 5: The CPUE (Number of legal size crabs per bait) for sites within the Sanma Province during each survey period (Fletcher, 2003).

Site	1985	1986	1987	1991	1993	2002
HOG HBR						
A	0.1	0.05	0.05	0	0	0
B	0.2	0.1	0.05	0	0	0
Ocean		0.1	0.05	0.04	0.14	0.11
Point		0.5	0.05		0.05	0.07
Cham. Beach					0.05	
Hill					0.05	
KOLE						
Close	0.05	0	0.03	0.06	0.07	0
Far	0.25	0.05	0.05	0.03	0.13	0
PORT OLRY						
Thion		0.02				0.09
MATANTAS						
Hill			0.04			0.35
Beach						0.25

10.1.5.2 Torba Province

The status of stocks varied amongst the islands in Torba province (Table 3). Tegua and Hiu (Torres group) still has substantial quantities of crabs (mean CPUE>2); with many sites having higher catch rates than was found 10 years ago. However, crab abundance in some other locations in Torba province have declined, especially Moto Lava in the Banks, while in Loh there are indications of grow overfished.

Table 6: The CPUE (number of legal size crabs per bait) for sites within the Torba Province during each survey period (Fletcher, 2003).

Site	1985	1986	1987	1991	1993	2002
TORRES						
Hiu						
Flatstone	4.8	3.2	1.82	1		1.96
Yurtawa			0.55	0.35		0.2
Tegua						
Site 1	4	2.5	0.7	0.4		0.87
Site 3			1.2	0.6		2.1
Site 4		0.8	1.8			0.68
Loh						0.02
BANKS						
Moto Lava						
Site 1				0.3		0.075
Site 2				0.1		0

10.1.5.3 Tafea Province

Assessment survey carried out in 2002 suggests that there are healthy stocks of coconut crabs on Erromango island. However, around Ipota area on the Eastern side of the island, there is a high exploitation pressure, resulting in first signs of local depletions. The current harvest of coconut crabs is approximately 1,500 crabs per year on the east side.

10.1.5.4 Penama Province

Initial survey in Penama province (Maewo) suggests that the level of harvesting in this region may be too large because the catch rates in some regions are relatively low.

10.1.6 Management

The current regulations stipulate that only 5,000 crabs can be collected in the Torres/Banks region with a further 2000 from Santo/Malo region, leaving a very large (13,000 crab) discrepancy with the totals sold (20,000). These extra crabs must either have come from collections in the non-quota locations such as Maewo and Erromango, or from "illegal" captures in the regions already under quota. Initial estimates from Maewo indicate that approximately 2,500 crabs were removed in 2003 whilst the collections from Erromango were in the region of 1500 – 2000.

10.1.6.1 Current legislation/policy regarding exploitation:

Fisheries Act CAP 158
Chapter 158. The Fisheries (coconut crabs) Regulation No. of 1991.

Closed season: Santo/Malo region – 31 October to 01 April
Torres/Banks group – 31 August to 01 November

Quota allowance: All islands in the Banks/Torres region – 5,000 per year
All islands in the Santo/Malo region - 2,000 per year

The regulation prohibits taking etc of coconut crabs carrying eggs and any crab less than 9 centimeters in length when measured along the carapace from immediately behind the rostral horn to the rear edge of the carapace in the mid-line. Removal of eggs from a coconut crab or possessing, taking etc of those from which eggs have been removed are prohibited under the same regulation.

Under the same regulation, the Director of Fisheries may grant permission upon application for the taking of crabs during the closed season for the purposes of scientific research.

Penalty
Any person who contravenes or fails to comply with any of the provisions of the regulations shall be guilty of an offence and shall be liable on conviction to a fine not exceeding Vatu 100,000.

Ban on Collection of Crabs from Sanma Province
A 3 years temporary ban on the collection of all crabs within the Sanma Province region was enacted by way of a regulation in 2004. The purpose of the ban is to stop further declines in the stocks in some areas of Sanma province.

10.1.6.2 Recommended legislation/Policy regarding exploitation

Sanma Province:
It is recommended that the quota for Sanma Regions should be divided into smaller regionally based quotas as specified below:

Region	Maximum Quota
North Santo – (Port Olry/Cape/Queros/Loran)	700
Hog Harbour	350
Kole	150
Shark Bay/Mavea	200
South Santo	300
Malo/Aore	300
TOTAL	**2,000**

The quotas specified above should be taken within each area. The quotas have been determined assuming that all areas are available for capturing the crabs.

Torba Province
It is recommended that the quota for the Torba province be regionalized. The suggested levels for each region are detailed below

SITE	PROPOSED QUOTA
Torres	
Hiu	1500
Tegua	1500
Loh	500
Toga/Metoma	200
Banks	
Moto Lava	400 (or lower)
Gaua	400 (or lower)
Other	500 (or lower)
Total	**5,000 (or lower)**

OTHER PROPOSED MEASURES

(i) An initial quota of 2000 coconut crabs should be implemented for the Tafea Province. This should be divided into 1,500 from the Ipota (Eastern) side and 500 from the Dillion Bay (Western) side. A close season should be implemented for the Tafea Province (and all the southern provinces) between January – March to protect spawning in these regions.

(ii) The quota for Maewo within the Penama Province should be reduced slightly from the current level to be 1500 crabs per year, with a close season that occurs at the same time as the Sanma Province.

(iii) There should be a trigger point of 500 crabs per year for any other Province/Island, which, if exceeded, would trigger the requirement for specific surveys and management to be introduced.

(iv) Director of Fisheries to have the power to halt collection of crabs at any time if there are indications of over harvesting

(v) The collection of information on the numbers of crabs being harvested needs to be improved by instigating a more accurate means of recording the numbers of crabs being sent to Vila from each regional airport, particularly Santo.

(vi) There should be regular 3-4 months surveys of the main restaurants and markets for crabs in Port Vila

(vii) Complete yearly/biyearly stock assessment surveys using local fisheries staff at each of the main sites to monitor the performance of the management arrangements.

10.2 LOBSTERS

10.2.1 The Resource

Species present:
Three species of rock lobsters; the pronghorn spiny lobster, *Panulirus pencillatus*; painted spiny lobster, *P. versicolor*; and longlegged spiny lobster, *P. longipes femoristriga* are present in Vanuatu. The slipper lobster also known as the Caledonian mitten, *Parribacus caledonicus* is also present.

10.2.2 Distribution

Panulirus pencillatus is the most widespread species of the spiny lobsters and is commonly found in the Indo-West Pacific and Eastern Pacific regions, from the Red Sea, East and South Africa to Japan, Hawaii, Melanesia, Samoa and the Tuamotu Archipelago and east to the islands off the west coast of America and in some localities near the continental coast of Mexico.

P. versicolor is present in the Indo-West Pacific region from the entire Red Sea and east coast of Africa, southern Japan, Micronesia, Melanesia, northern Australia and Polynesia.

Parribacus caledonicus is found through out Indo-West Pacific region in Queensland, Australia; New Caledonia and Loyalty islands; Vanuatu; Fiji and Samoa.

P. longipes femoristriga is found in waters of Japan, the Molluccas, Papua New Guinea, Vanuatu, eastern Australia, New Caledonia and French Polynesia.

Within the Vanuatu archipelago, *Panulirus pencillatus* and *Parribacus caledonicus* inhabits the "weather"sides (east and south) of the islands. *Panulirus pencillatus* is found around Anietyum, Futuna, Tanna, Erromango, the south and east of Efate, the shepherd islands, cooks reef Ambrym, Pentecost, Maewo and south and east coast of malekula and Espiritu Santo. *P. longipes femoristriga* has been reported to be present on Tanna and in the northern region and on Maskelyne Island, Malekula and along the west coast of Espiritu Santo, while *P. versicolor* is found in abundance in the northern islands as well as from around Efate, Tanna and other southern islands.

10.2.3 Biology and Ecology

Rock Lobsters belong to the phylum Arthropoda. This phylum contains a vast assemblage of animals and over 7500 species have been described to be within the phylum (ruppert & Barnes, 1994). There are four subphyla (trilobita extinct), which include; spiders, mites and scorpions (Chelicerate), centipedes, millipedes, and insects (Uniramia) and Copepods, barnacles, shrimp, losters and crabs (Crustacea).

Rock lobsters belong to the class Malacostraca and order Decapoda. There are approximately 10,000 species of decapods and these species are distinguished from other malocrustacea by having the first three pairs of thoracic appendages being modified as maxillipeds.

Spiny lobsters are considered opportunistic and omnivorous scavengers preying on gastropods, crustaceans, echinoderms, seagrass and algae (Philips *et al.*, 1980, quoted in Pitcher 1993). Rock lobsters are nocturnal and not gregarious (Holthuis, 1991). They reach sexually maturity at 7 – 10 years of age. Once breeding begins it is continuous through out the year, however it is reduced in cooler seasons. Mating in most aquatic decapods occurs shortly after female moulting and the sexes are attracted to each other by pheromones before or after moulting (Ruppert & Barnes, 1994). The female carried the eggs under its tail for one month before tiny phyllosoma larvae are released (Pitcher 1993). The larvae remain in the ocean for 4 – 12 months before moulting into the puerulus stage, about 50 mm in length, resembling a colourless miniature adult. At this stage it undertakes the transition from the oceanic to the benthic environment, where they settle in or near the adult habitat and quickly moult into pigmented juveniles (Philips & Sastry, 1980, quoted in Pitcher, 1993). Due to wide spread dispersal of larvae particularly, *Panulirus pencillatus* phyllosoma larvae and the existence of a number of unexploited reefs to provide recruitment to exploited reefs, this species is probably resilient to recruitment overfishing.

Panulirus pencillatus is the main rock lobster species harvested in Vanuatu waters by coastal rural communities and occupies the same habitats as *Parribacus caledonicus,* that is “weather” sides of the islands amongst the surf, surge channels and undercut *Porolithon* alga reef where it is sheltered away from light and there is good water circulation and has depths ranging from 2 – 6 meters. They often hide in crevices and marine caves in the day time, often attached to the ceiling of the caves. Best habitats are spurs of reef running offshore.

P. longipes femoristriga is a smaller species than *Panulirus pencillatus* and live in deeper waters up to 122 meters. Less numbers are found on reef flats. *P. longipes femoristriga* favours compact reefs particularly those receiving moderate but regular surf action with small blowholes through the narrow fringing reef flats. These reef types are common around Malekula Island and the west coast of Santo.

P. versicolor is the largest of the three species and inhabits quiet, turbid or clear waters down to 37 meters. It also lives in silty, quiet lagoon waters, often near stream mouths or deeper on the outside face of reefs receiving moderate to high wave action.

10.2.4 The Fishery

10.2.4.1 Utilization

Exploitation of rock lobsters in Vanuatu is widespread both for subsistence and as a source of income for mainly rural coastal communities. The lobsters are harvested by hands from free diving using masks and snorkels at moonless nights with an aid of a torch light or during day time. A small experimental fishery was initiated at Tanna and other southern islands using beehive cane or wicker pots two to three feet in diameter, baited with chitons or sea urchins. Pots were set on the reef edge in reasonably sheltered pools or crevices, often covered with stones, and out beyond the reef to at least 122m. Pot trapping was unsuccessful with *P. versicolor* as they could not be enticed into pots. On the shallow reef, fishermen regularly catch lobsters either by diving or on foot on the reef during moonless nights (David, 1985).

10.2.4.2 Production and marketing

Like other marine resources, rock lobsters are harvested for both subsistence and commercial purposes in Vanuatu. The resource plays a significant role as a source of cash revenue for coastal communities. Main commercial markets are located in Port Vila, Efate and Luganville, Santo. In 1983 an estimated production of 490 tonnes of lobsters were harvested of which 45% of was sold at the Port Vila markets earning an estimated amount of approximately VT122 million (David and Cillaurren 1992).

Baird in 1973 reported a CPUE of two to three sacksfull a night in Santo and Lamap (south Malekula island), with estimated weights to be between 50 – 100 kg. Value per kilogram of crab was AUS$1.00 (equivalent to VT80).

The artisanal harvest of lobster for 1983 was estimated to be approximately 20.5 % (490t) of the subsistence harvest of 2,402 t of marine organisms annually (David, 1985) worth an estimated value of more than US$1 million. Of the total harvest, approximately 555t were produced for sale of which 45% was of crayfish and 42% was made up of fish. The estimated market value was VT147 million of which 83% was attributed to rock lobster. Of the crustaceans, lobsters are the only ones being actively marketed, with half of the catch offered for sale (David and Cillaurren, 1992). Dalzell (1990) reported that "anecdotal sources suggest that lobsters are increasingly important as a source of cash revenue for villagers and increasing amounts are sent by air to Port Vila". The amount and value of spiny and slipper lobsters landed at the Natai Fish Market from 1988 to 1992, and between 1983 and 1984, are as follows (source: Fisheries Department Data Base and Crossland, 1984).

Table 7. Quantity of lobsters and slipper lobsters landed at Natai Fish Market

	May 83-July 84	**1988**	**1989**	**1990**	**1991**	**1992**
Lobster (kg)	3,306	1,810.0	850.4	1,301.3	1,716.3	1,483.2
Value (Vatu)		1,020,110	511,515	396,428	1,604,385	1,042,551
Slipper Lobs		0	37.3	0	9.1	71.9
Value (Vatu)		0	11,005	0	2,730	28,920

Lobsters purchases between July 1983 and July 1984 at Santofish amounted to 120 kg (Crossland, 1984).

From 1990 to 1992, the Fisheries Extensions Centers purchased lobsters but the data is mixed together with those of coconut crabs under "Other Species". Even though the species in this category seem to have comparatively small inputs into the Extension purchases, these species are important to the other sectors within the country at both subsistence, artisanal and commercial levels. The category is shown below (source: Fisheries Department Data Base).

Table 8. Purchased lobsters recorded as “others”

	1990	**1991**	**1992**
Total numbers	168	421	444
Total weight (kg)	503.8	2,081	4,651.2

In 2003, the Department of Fisheries banned the issue of Fish Establishment Export License for rock lobsters overseas. This was due to the fact that the status of stocks of rock lobsters was not very healthy. However, lobsters were still allowed to be harvested but only for the domestic market consumption. Summarized in the table below are exports figures for the years 1999 to 2003 (Source: Fisheries export permits)

Table 9: Quantity of lobsters export

Year	**Quantity (kg)**	**Value (VT)**
1999	70	42,000
2001	3,494	3,403,650
2002	758	838,772
2003	10	2,000

10.2.5 Stock Status

Assessment surveys carried out by the Department of Fisheries indicated that status of rock lobster stocks in Vanuatu is in danger of being over fished. The exploitation level is determined by the access availability to the urban markets of Port Vila and Luganville and the population size of the island or the coastal communities.

The population of rock lobsters varies from island to island. The size of the population is determined by the nature of the habitats or fringing reefs. Some islands seem to have high populations of a particular lobster species compared to other islands. Surveys carried out on the Shepherd islands, (Buninga, Makira, Emae, Tongariki and Mataso) indicated that the double-spined and blue-spot rock lobsters were the predominant species. Makira and Mataso islands recorded the highest occurrence of lobsters. There were very few slipper lobsters recorded during the assessment survey, thus implying that the status of stocks for slipper lobsters is near depletion.

Assessment surveys carried around Malekula however, indicated that the predominant species was painted spiny lobster (*Panukirus versicolor*). The absence of blue spot lobster on the survey sites may be due to its high commercial value and the ease with which the lobster can be sold or freighted out from Malekula either to Port Vila or Luganville.

The assessment surveys concluded Erromango, Aneityum and the islands of the Torres/Banks group as having very high stocks of rock lobsters.

10.2.6 Management

10.2.6.1 Current Legislaion/Policy regarding exploitation

Fisheries Regulation under the Fisheries Act CAP 158 of 1982, Prohibits taking, possessing, selling or purchasing of:

(i) any rock lobster carrying eggs; or

(ii) any rock lobster which is less than 22 centimeters in length when laid flat and measured from immediately behind the rostral horns to the rear edge of the telson or whose carapace is less than 7.5 centimeters when measured along the mid-line from immediately behind the rostal horns to the rear edge.

The same regulation prohibits spearing of lobsters as well as removal of eggs or possession, selling or purchasing of lobsters from which eggs have been removed.

For slipper lobster, *P. caledonicus*, the above regulation applies except that the minimum length is 15 centimeters measured from the front edge of the carapace to the rear of the telson. Penalties for violation of these regulations is a fine of up to VT100,000.

10.2.6.2 Recommended legislation/policy regarding exploitation

Given the high exploitation levels of lobsters, it is recommended that the Department of Fisheries should:

- Carry out a thorough rock lobster stock assessment
- Place a closed season for harvesting of rock lobsters, especially during the period with which the female lobsters are carrying eggs
- Allocate quotas for each provincial region

10.3 FRESH WATER PRAWNS

10.3.1 The Resource

Species Present:
The main endemic species commonly found in rivers, streams or lakes in Vanuatu are those of *Macrobrachium lar*. However there are several species of fresh water shrimp that are present Vanuatu but are not in sufficient quantities to be able to sustain any industry.

In the late 1970's the culture of the giant Malaysian fresh water prawn, *Macrobrachium rosenbergii* was tested in Vanuatu but failed due to high mortality rates experienced.

10.3.1.1 Distribution

The distribution of fresh water prawns is wide spread through out Vanuatu particularly on islands where there are rivers, streams or lakes. Stock abundance has been identified on Santo, Malekula, Maewo, Erromango, Efate, Epi and Anietyum island.

10.3.1.2 Biology and Ecology

The biology of the fresh water prawn *Macrobrachium rosenbergii* is well known. Larval cycles during the hatchery phase as well as the species grow out performance in aquaculture are documented in numerous articles.

As regards to *Macrobrachium lar* little is known about the biology and its larval cycle. However, the one thing that is known for certain is that it has a very slow growth rate and has an ability to abandon ponds to wonder off through wet grass, thus making this local species it not suitable for aquaculture farming.

10.3.2 The Fishery

10.3.2.1 Utilization

Normal method for harvesting is by way of use of traps, spears, and hands. In islands such as Pentecost and particularly Maewo, taro farmers rear the local fresh water prawn species in their irrigated taro patches. Draining of these irrigated taro patches is another way of harvesting the *Macrobrachium lar.*

The local fresh water prawn is harvested for both the subsistence and commercial purposes. For subsistence use, the prawns are caught by spearing, however, for commercial purposes the prawns are caught using traps to maintain of a good quality to obtain better financial return. Current purchasing price per kilogram of local fresh water prawn from harvesters is VT500 – VT1,000. Retail price is VT1,500 per kilogram. Freshwater prawns are normally brought in from the islands and rural inland areas of Santo and Efate and are sold to middle-men buyers or directly to restaurants and hotels.

To date no major aquaculture farming of fresh water prawn has taken place. However in the late 1970's a local company initiated a trial fresh water prawn farm but due to rearing difficulties and lack of technical know how, the trail farm was terminated in early 1980's.

Given the high demand for freshwater prawns at the domestic markets, the Department of Fisheries as part of its 2004 development activities initiated research studies on the possibilities of farming *Macrobrachium rosenbergii*. The intension is to introduce this freshwater prawn species in to Vanuatu from Fiji, where successful trails have been achieved.

With funding assistance from ACIAR, the Department of Fisheries Research and Aquaculture Division commenced farming trials of *M. lar* at Sarate, South Santo. Juveniles are netted or collected from the wild and reared in impounds (4 m x 6 m) with stocking densities of 5 prawns per 1.0 square meter. The intention of this aquaculture research is to determine the socio-economic viability of farming of this native fresh water prawn.

10.3.2.2 Production and Marketing

The only freshwater prawn of species *M. lar*, production estimated was made in 1983 where an estimated annual production of 18 tonnes, representing 0.7% of the annual rural fishing production, was determined for Vanuatu. In 1986, Japan International Cooperation Agency (JICA) reported a fresh water prawn yield of 12 tonnes for Vanuatu in 1984.

From 1988 to 1992 the Government owned Natai Fish Market, (now liquidated) purchased from rural communities quantities of fresh water prawns. Production figures are as follows:

Table 10. Production figures for the years 1988 to 1992

	1988	**1989**	**1990**	**1991**	**1992**
FW prawns (kg)	88	422.6	271.6	136.9	67.1
Value (VT)	70,400	336,470	657,280	90,545	49,730

Most of the catch of this resource is consumed on the subsistence level. Yields from the fresh water areas for subsistence purpose have been estimated to be about 56 tonnes per year (Second National Development Plan, 1987-1991).

10.3.3 Stock Status

To date no stock assessment surveys has been directed towards estimating or assessing the stocks of the *Macrobrachium lar* in Vanuatu. However, fresh water prawns are continually being harvested and are sold directly to either the restaurants or the hotels at an average price per kilogram of VT1,000.

10.3.4 Management

Current management regimes are self-regulation for this resource, even though fresh-water prawns are a commercially marketed resource.

10.3.4.1 Current Legislation/Policy regarding exploitation

There is no current legislation regarding the exploitation of this resource.

10.3.4.2 Recommended Legislation/Policy

The following options should be considered as possible management measures

(i) Prohibit or ban the use of all chemicals to catch or harvest this resource by collectors;
(ii) Develop criteria to manage such economic developments as cattle farming, habitat destruction, deforestation, irrigation, aquaculture, etc., that may have detrimental impacts on the resource; and
(iii) Develop criteria for introduction of fresh water exotic species into the river systems.

10.4 LAND CRABS

10.4.1 The Resource

Species present:
Three species of land crabs all belonging to the genus *Cardisoma* exist in Vanuatu (Lal and Esrom 1990).

10.4.1.1 Distribution

Land crabs occur throughout Vanuatu but abundance is only restricted to a number of islands such as Malekula, Santo, Emae and Efate.

10.4.1.2 Biology and Ecology

Lal and Esrom (1991) wrote that the *cardiosoma sp*. is caught on the outskirts of mangrove areas and along the sandy strand bordering *Rhizophora* mangroves. Adults appear to live in the inland areas amongst the ground cover vegetation or in under ground burrows mainly around swamp areas and come at night to feed.

Gravid females carry their eggs until they hatch. Eggs are dark blue. Gravid females are often observed eating leaves. They go to the seaside to release the larvae. Some females drown doing this.

Around two days before the full moon, especially during the summer months, the crabs emerge at dusk and undertake mass migrations to the sea. The larvae are released from the eggs into the sea by vigorous flapping of the abdomen. A berried female is able to release up to 425,000 larvae.

Release of larvae at spring tides presumably maximizes dispersal along the coast. It has been reported that spawning migration in Vanuatu is during new moon (dark nights).

Cardisoma carnifex, berried female

Typical Carisoma habitat in Vanuatu which is normally associated with inland mangrove areas and swamps.

Cardisoma hirtipes

10.4.2 The Fishery

10.4.2.1 Utilization

In the past the capture (collection) of land crabs was mainly for home consumption, however, this resource now has a commercial value. Crabs are caught at night during their migration to spawn, but normally they are caught at around dusk. In islands where the crabs are abundant, for example Emae and Uri island collection can be made at any time during the day. Given the recent commercial value of the crabs, rural communities on other islands of Vanuatu are now collecting and exporting the crabs, via air freight or trading vessels, to Luganville and Port Vila Municipal markets for sale.

In areas where crabs are abundant some are offered for sale in bundles or small baskets. On Emae island crabs are offered for sale at the Aromai airport to aero-plane passengers at VT200 a basket. In Siwo village on Emae island members of other communities pay a collection fee of VT700 per person before they can collect land crabs on areas of land owned by the Siwo community. In Port Stanley on Malekula, *C. hirtipes* is regularly caught mostly for subsistence as well as for selling. Lal and Esrom (1990) report that all households in this area harvest "nevri" for subsistence, but a large proportion of them also sell crabs in the Norsup market, mostly on Saturdays. Some are air freighted to Vila via middlemen buyers.

10.4.2.2 Production and marketing

There are no records of land crab production in the Republic except some estimates made for Norsup market on Malekula. On Emae where crabs are abundant, they are sold at the airport in baskets for VT 200 per basket, targeting those flying out to Vila. On Efate crabs that are sold come mostly from Erakor and Eton though probably also from Northern Efate. At the open market in Vila, a basket is sold at VT 500. A basket has been estimated to contain 10-20 crabs. The crabs are also sold in bundles or strings at VT50 per crab.

On Malekula (in Port Stanley), Lal and Esrom (1990) reports that on a Saturday (5/5/90) seventeen women were selling an average of 10 bundles each. They estimated a weekly production for that market at 170 bundles. Using 10 crabs per bundle, 2 kg/bundle and VT 100/bundle, an estimate was made of 8,500 bundles (thus 17,680 kg) worth VT 850,000 are marketed via Norsup market annually. Some of these were bought by at least two individuals who were known to airfreight them to Port Vila where they are sold at VT 250-300 for a bundle of five crabs.

10.4.3 Stocks Status

No data nor any attempt has been made to collect any information on the land crabs. However, observations made on locations where there are abundant land crab populations, such as Crab Bay on Malekula island; Siwo and Vaitini on Emae Island, indicated a reduction in the overall population.

10.4.4 Management

10.4.4.1 Current legislation/policy regarding exploitation:

No legislation exists that concerns the exploitation of land crabs. However, Crab Bay has now been declared a reserve to allow such resources as land crabs to propagate.

10.4.4.2 Recommended legislation/policy regarding exploitation:

There does not seem to be any need to regulate the resource at present. However, if exploitation gets high in the main areas, e.g. Port Stanley, or Emae island, limiting or banning the export to Vila might be a consideration. However, collection of data would be necessary to see any trend.

10.5 DEEP-WATER SHRIMPS

10.5.1 The Resource

Species present:
Seven species of the caridean shrimps have been reported in waters of Vanuatu at depths between 229m and 650m. They all belong to the family Pandalidae and at least three genera; *Heterocarpus*, *Plesionika* and *Parapandalus*.

The species are listed by King (1986) to include, *Parapandalus (=Plesionika) serratifrons (*the pyjama shrimp), *Pleisionika longirostris (=edwardsii)* (stars and stripes shrimp), *P. ensis* (striped gladiator shrimp), *Heterocarpus ensifer* (armed nylon shrimp), *H. sibogae* (mino nylon shrimp), *H. gibbosus* (humpback nylon shrimp), and *H. laevigatus* (smooth nylon shrimp).

10.5.1.1 Distribution

The distribution of *Heterocarpus* species is at least in the Indo-Pacific and has been found in India and islands in the Indian Ocean as well as the Pacific Islands from Palau in the west to French Polynesia in the east (King, 1993). Species occupy particular depths but with overlapping ranges with the smaller shrimps (*P. serratifrons* and *P. edwardsii*) being widely distributed in shallower waters (< 400 m). The medium-sized *Heterocarpus*, *H. sibogae* and *H. ensifer*, predominate catches over 400 m and *H. laevigatus*, one of the largest species, is common in depths of more than 500 m.

King (1980) found that within Vanuatu, catch weight of *H. ensifer* varied significantly with depth whereas *Pleisionika longirostris* accounted for up to about half of the shallow water catch. *H. ensifer* occurred throughout the sampled depth range but catches between 400-500m consisted almost exclusively of this species. The *H. laevigatus* catch proportion increased in the deepest depths with a corresponding decrease in the *H. ensifer*. The following table (Table 1.5.1) shows the species composition by weight expressed as a percentage of the total shrimp catch in each depth. In the shallowest depth sampled (229 m) *P. serratifrons* accounted for 31 % of the small total catch.

Table 11: Species composition by weight (% of total catch) at each depth (King, 1980).

Depth (m)	*P. longirostris*	*H. ensifer*	*H. laevigatus*	Other species
229	15	54		31
262	51	48		1
324	47	49		4
384	27	73		0
421	< 1	99		< 1
436	< 1	99		< 1
454	2	98		0
461	< 1	99		< 1
560		57	43	0
650		68	32	0

The Fisheries Department and ORSTOM in 1982 conducted a survey at depths between 400 m and 700 m. The best results were obtained between 450m and 500m (Wright, 1989).

10.5.1.2 Biology and ecology

Deep-water caridean shrimps have separate sexes (King, 1993). Biological parameters for *H. laevigatus* in three countries are given in same with figures obtained in Fiji reproduced below in Table 1.5.2. Female sexual maturity in this species is attained between 4 to 4.6 years (40-43 mm

carapace length) and spawning seems to be in winter. Growth parameters[3] for some other species are also given and are reproduced below.

Table 12: Some biological parameters of a few deep-water shrimps (King, 1993).

Species	L∞ (mm)	K(yr^{-1})	M (yr^{-1})	L_C	t_C
*H. laevigatus**	57	0.27	0.66	40.5	4.6
P. edwardsii	29.5	0.66			
H. sibogae	41	0.38			
H. gibbosus	45	0.35			

*figures for Fiji.

King (1993) notes that the "combination of slow growth rates with high natural mortality rates suggests that the biomass (weight) of shrimps from a given recruitment is maximized at an early age, after which the available biomass rapidly declines".

10.5.2 The Fishery

10.5.2.1 Utilization

A few species of carid shrimps form the bases of commercial fisheries. For example, carid shrimps are commercially harvested in Alaska, North America and Chile (King, 1986) and also in Europe, Japan and Chile (Crossland, undated).

There has been no fishery based on deep-water shrimps in Vanuatu, even though this resource can be utilized for speciality food items in local restaurants and possibly export.

Baited two-entrance box traps were used for the survey in Vanuatu by King (1980). Some were covered with hessian sacking while others were not.

In parts of the world where carid shrimps are commercially exploited, trawls of various types are the main method of harvesting. "This method is of little use to the South Pacific region as, apart from the Gulf of Papua in PNG, there are no areas of continental shelf. Most of the potential fishing grounds in the Pacific consists of uneven or sloping bottoms unsuitable for trawling, which can best be fished with traps" (Crossland, undated).

10.5.2.2 Production and marketing

H. ensifer was the only species that occurred over the entire depth range surveyed and catches of individual species varied with depth. In addition dominant species in a particular depth range differ. When grouping the catch data in 100 m depth ranges, it was estimated that the "total mean catches were low in shallower water but increased with depth to a maximum in 500 to 600 m" (King, 1980) which gave a mean catch rate of 2.83 kg per trap. Shrimp abundance seemed to decrease beyond this range. However, King noted that the important factors for consideration when contemplating a fishing strategy include the catch weight and the size of individual shrimps.

Best catches made by the Fisheries Department /ORSTOM 1982 survey averaged 1.0 kg per trap with the catch comprising mainly of *H. sibogae* and *H. laevigatus*. The results were considered to show limited economic potential for the development of this fishery in the vicinity of Port Vila.

The preliminary survey by King in 1983 produced catches that were considered high enough for consideration for commercial trials. King (1986) provided the following table comparing catch rates and optimum depths of Caridean shrimps from different countries:

Table 13: Catch rates and optimum depths of Caridean shrimps from different countries

Location	Catch rates (Kg/trap)	Optimum Depth (m)	Comments & References
Hawaii's Northwestern group	2.9	550 - 600	Catch of *H. ensifer* and *H. laevigatus* combined (Gooding,1984)

[3] L_∞ is the asymptotic carapace length, K is the growth coefficient, M is the natural mortality rate, L_C is the mean length at first reproduction and t_C, the relative age at first reproduction

Guam's Western Coast	2.1	440 - 680	Catch of *H. ensifer* and *H. laevigatus* combined (Wilder,1977)
Western Samoa, near Apia	1.4	500 - 600	Catch of *H. sibogae* and *H.laevigatus* combined (King, 1980, 1984)
Tonga, near Nuku'alofa	0.6	600 - 700	Catch of *H. sibogae* and *H. laevigatus* combined (King, 1981b, 1984)
Fiji, near Suva	1.2	450 - 650	Catch of *H.sibogae, H. gibbosus* and *H. laevigatus* combined (King,1984)
Vanuatu	2.8	500 - 600	Catch of *H. sibogae* and *H. laevigatus* combined (King, 1981a, 1984)
New Caledonia	2.0	800	Catch of *H. laevigatus* (Intes, 1978)

No attempt has been made to further assess the feasibility of deep-water shrimp exploitation for commercial purposes in Vanuatu.

10.5.3 Stocks Status

The resource is not exploited and information on standing stocks is not known. More detailed assessment research is needed. Ralston (1986, quoted in King, 1993) reported a drastic decline in catch rates, from 3.3 to 1.8 kg per trap-night over a 16 day intensive trapping experiment for *H. laevigatus* in the Marianas. The decline in catch rates was attributed to the decline in shrimp numbers suggesting that the species may be vulnerable to even moderate trapping in that area (King, 1993).

10.5.4 Management

A more comprehensive assessment on this particular potential resource is required to give some indications of stocks available for exploitation and its likely economic potential. Results of such research work will indicate strategies to be taken if exploitation is likely.

10.5.4.1 Current legislation/policy regarding exploitation:

No current legislation.

10.5.4.2 Recommended legislation/policy regarding exploitation:

Not necessary until the resource stock is assessed and utilization initiated.

11. FIN-FISHES (OSTEICHTHYES)

11.1 DEEP-WATER BOTTOM FISHES

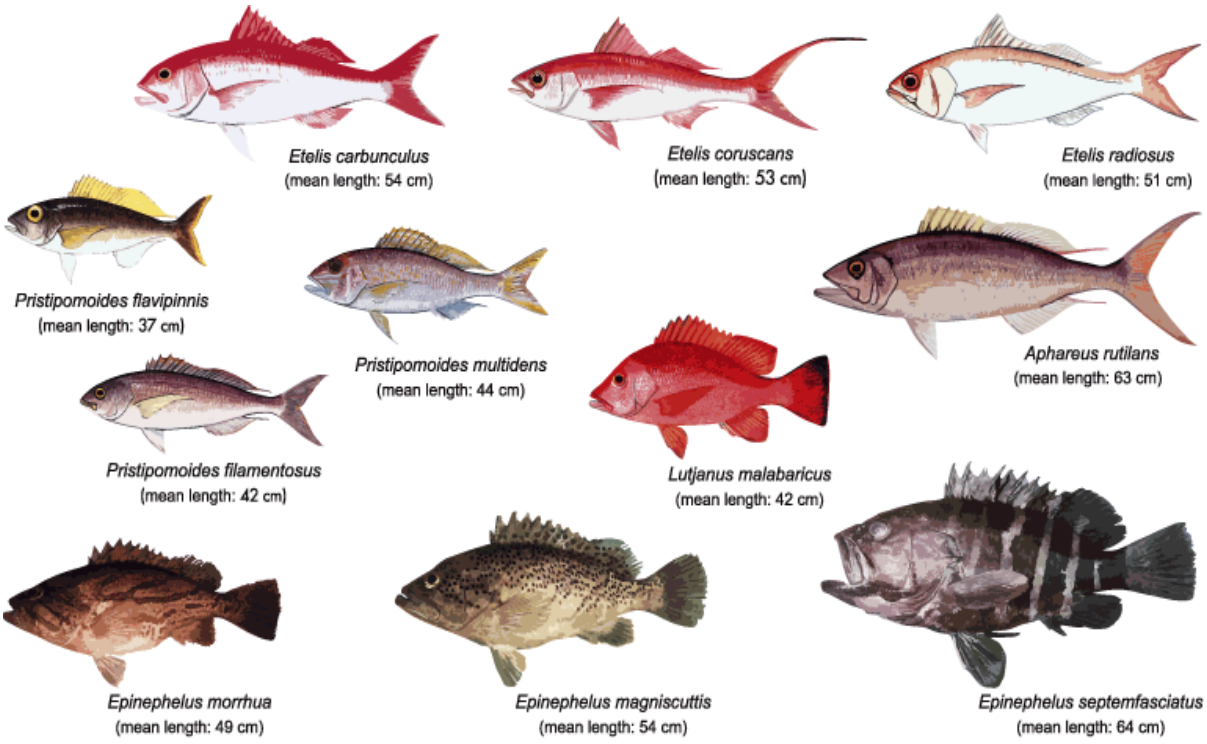
11.1.1 The Resource

E. coruscans

Species present

One hundred and seven species were recorded by Brouard *et al*. (1985) with best represented families being the Lutjanidae (subfamilies Etelinae, Lutjaninae and Apsilinae), Serranidae (subfamily Epinephelinae) and Lethrinidae.

The eleven main species listed by Schaan *et al* (1987) include, *Lutjanus malabaricus*, *Etelis carbunculus*, *E. coruscans*, *E. radiosus*, *Pristipomoides filamentosus*, *P. flavipinnis*, *P. multidens*, *Aphareus rutilans*, *Epinephelus magniscuttis*, *E. morrhua*, *E. septemfasciatus*. Other species include; *Aprion virescens, L. gibbus, L. bohar, L. rufolineatus, L. argentimaculatus, L. timorensis, Lethrinus variegatus, L. miniatus, Paracaesio kusakarii* and *T. zonatus*.



Sources: from the illustrations in the "FAO Species catalogue", Vol. 6 & 16, Rome, 1985, 1993

11.1.1.1 Distribution

Through out the South Pacific, the most important fish catch components of the deep-water fishery, in terms of total landing and value, comprise snappers and groupers. Most of the species in these two families are "widely distributed throughout the central, western and South Pacific although species richness tends to decline with distance from the Indo-Pacific faunal center, leaving areas like Hawaii with somewhat fewer species" (Moffitt, 1993). Allen (1985) gives an overall general distribution pattern by subfamilies in the family Lutjanidae as well individual species known distribution and identification. He also writes that "the family is divisible into four discrete geographical faunas: eastern Pacific, Indo-West Pacific, eastern Atlantic and western Atlantic" with no species found in more than a single region. Furthermore, many species, particularly members

of *Aphareus, Aprion, Etelis, Lutjanus, Macolor, Paracaesio, Pinjalo* and *Pristipomoides* have broad distributions encompassing wide areas of the Indo-West Pacific region. Some of these species such as *Lutjanus bohar, L. gibbus, L. kasmira, L. monostigma,* and *L. rivulatus*, as well as species of *Etelis*, *Paracaesio* and *Pristipomoides* are frequently associated with oceanic insular localities. Relatively few species have greatly restricted distribution and some of these may be more widespread, but because of their relatively deep habitat, they are seldom collected. Moffitt (1993) notes that even though most of these species are wide ranging, their relative composition in catches varies considerably with location.

The deep-water bottom-fish inhabit the outer reef slope at depths ranging from 100 to 400m (Brouard, 1985 and Schaan *et al,* 1987). This area has been estimated by Davis (1985), by region within Vanuatu, to be approximately 754,685 ha as given in the table below.

Table 14: Surface area for the 100-400 m depth band, by region, in Vanuatu (David, 1985).

Area	Surface 100-400 (ha)	Percentage of Total	Area	Surface 100-400 (ha)	Percentage of Total
Torres	20,596	2.7	Epi-Paama-Lopevi	76,512	10.1
Banks	51,876	6.9	Efate	95,330	12.6
Santo-Malo	142,970	18.9	Erromango	55,658	7.4
Maewo	33,468	4.4	Tanna-Aniwa	47,568	6.3
Pentecost	25,000	3.3	Futuna	3,700	0.5
Malekula	101,344	13.4	Aneityum	14,816	2.0
Ambrym	26,650	3.5			
			Vanuatu Total	**754,685**	**100**

However, this does not indicate areas that are potentially rich in bottom-fish, as sea bed charts would be required. Brouard and Grandperrin (1985) gave depth ranges for 84 different bottom fish species in Vanuatu. Classification of species by three depth zones of maximum concentration as recorded during deep bottom fishing in Vanuatu was also given. This is shown for some commonly caught species in Table 11, below:

Table 15. Classification of the major species by depth zone of maximum concentration

Shallow species (<120 m)	Intermediate depth species (120-240 m)	Deep species (>240 m)
P. filamentosus	*P. multidens*	*E. carbunculus*
A. virencens	*P. flavipinnis*	*E. coruscans*
L. gibbus	*L. malabricus*	*T. argyrogrammicus*
L. bohar	*E. morrhua*	*S. megalops*
C. amblyrhinchos	*S. rivoliana*	*E. radiosus*
L. variegatus	*L. miniatus*	*L. carnolabrum*
	A. rutilans	*E. septemfasciatus*
	A. rutilans	*T. zonatus*
	L. argentimaculatus	
	E. magniscuttis	
	G. mossambicus	
	E. chlorostigma	
	E. areolatus	
	L. rufolineatus	
	P. kusakarii	

The vertical distribution of the fishing effort shows two peaks located between 150 and 200 m and between 250 and 300 m depths, with a subsequent sharp decline to a minimum at around 400 m. Fishing yields (weight) increase steadily from the surface to reach a maximum at 400 m depth. There is almost no fishing effort below 500 m depth.

The vertical distribution of fish species shows clear habitat stratification. *Pristipomoides* spp. and *Lutjanus malabaricus* inhabit the water layer between 25 m and 300 m depth. *Etelis* spp. are the

main fish caught below 200 m depth, and *E. carbunculus* is caught at the deepest levels. Groupers (*Epinephelus* spp.) and *Aphareus rutilans* are the most common species in the intermediate waters between 100 and 350 m depth–these fish do not seem to be very depth-specific.

The two main *Etelis* species, *E. carbunculus* and *E. coruscans*, are mainly fished near islands in the archipelago that are exposed to southeasterly winds. *E. radiosus*, the third species of the group, seems to be widely distributed but with maximum yield recorded at Tongoa and Tanna. Moreover, especially high yields were recorded at Maewo and Paama for *E. carbunculus* and at Maewo for *E. coruscans*.

As noted for *Etelis* spp., the three *Pristipomoides* species seemed to be widely distributed around many islands, but there were similarities with respect to the geographical distributions noted for *E. radiosus*. Tongoa recorded the highest CPUEs for *P. multidens* while there were very high yields of *P. filamentosus* at Tanna. The *Epinephelus* group is mainly caught in Ambrym, Pentecost and Tanna. *L. malabaricus* has declined throughout Vanuatu from north to south and east to west. *A. rutilans* catches are specifically localized around Maewo.

The largest fishing grounds within the country are off the east coast of Santo. Around Efate, the fishing effort during the 1987-88 period seemed to have concentrated in the north east Efate region, Emao and Forari (Cillaurren, 1988).

11.1.1.2 Biology and ecology

It has been established that benthic fish and crustaceans form an important dietary component for deep-water snappers and groupers and that pelagic urochordates are important prey items for many *Pristipomoides* species (Moffitt, 1993). Deep-water snappers are serial spawners able to spawn several times over a prolonged breeding season. Reproduction takes place in the summer, May to September in the North Pacific and November to May in the South Pacific. Fecundity increases with size and for some species it has been estimated to be between 300,000 and 2,000,000 eggs. Groupers on the other hand are protogynous hermaphrodites with an abbreviated breeding season peaking for 1-2 months. Groupers aggregate in large numbers during spawning and they usually become susceptible to fishing during this period. Fecundity has not been determined. Both snappers and groupers are long lived and slow growing. For natural mortality (M), Ralston (quoted in Moffitt, 1993) found the relationship M=0.0189+2.06K for snappers and groupers.

Examining catch data within Vanuatu Brouard and Grandperrin (1985) found that the only significant sex ratio possible was that calculated from fishing trials carried in Santo for 656 *P. multidens*, giving a male to female ratio of 1:18. The same authors hypothesized, using results from microscopic examination of fresh gonad for different stages of maturation that shallower species have maximum breeding activity in summer, although capable of spawning all year round, while deep water species do not have such a marked cycle. In all species intense sexual activity in the spring (months 10 and 11 - Oct/Nov) seems to be very common. Length at sexual maturity (L_m) were calculated by same authors for 26 deep-water species, without any sex distinction, as presented in Table 2.1.3 Because of limited numbers in samples for estimating L_m, the authors were limited to determining the smallest size recorded of sizes associated with sexual maturity on the basis of the occurrence of a high GSI (gonosomatic index[4]) and maturation stages 5, 6 and 7. (Appendix 2.1 (a). lists the stages for sexual maturation scale used). In addition the Beverton and Holt relationship $L_m=kL_{max}$ was used. The K value (K=0.576) used was that obtained for 34 tropical fish species on the West Coast of Africa. The choice not to use k=0.71 as calculated by Loubens (1980) for New Caledonia was that maximum lengths obtained were much higher than those in New Caledonia which would have yielded higher values than actual.

[4]GSI was calculated by dividing the weight of both gonads (in grams) by the weight of the whole fish body (in kg).

Table 16: Minimum sexual maturity sizes recorded and calculated sexual maturity sizes($L_{m)}$ using L_m=0.576 mean L_{max} (after Brouard and Grandperrin, 1985).

Species	**Minimum sizes with raised GSI *1**	**Minimum sizes associated with stages 5, 6 and 7 *2**	**Lm*3**	**Species**	**Minimum sizes with raised GSI *1**	**Minimum sizes associated with stages 5, 6 and 7 *2**	**Lm*3**
A. rutilans			48	*L. argentimaculatus*			44
A. virescens			44	*L. bohar*			36
E. areolatus			22	*L. gibbus*			21
E. magniscuttis			40	*L. malabaricus*	38	38	35
E. morrhua	44	41	44	*L. rufolineatus*			16
E. septemfasciatus			83	*P. kusakarii*			33
E. carbunculus	28	30	54	*P. filamentosus*			35
E. coruscans	38	33	47	*P. flavippinis*	28	27	33
E. radiosus		31	40	*P. multidens*	32	33	37
G. mossambicus			25	*S. rivoliana*			49
L. miniatus			42	*S. megalops*			47
L. variegatus			30	*T. argyrogrammicus*	21	19	14
L. carnolabrum			35	*T. zonatus*			20

**1 = minimum sizes for which the GSI was above the mean GSI calculated for maturation stage 5*

**2 = minimum sizes where maturation stages 5, 6 and 7 were first noted.*

**3 = sexual maturity sizes worked out from mean maximum lengths (Lmmax) using the formula Lm=kLmmax, where K=0.576.*

The growth rates of the main Lutjanidae species occurring on the outer reef slope of Vanuatu seem to be very low, lower for the more deeper ones like *E. carbunculus* and *E. coruscans* than shallower *P. flavipinnis* and *P. multidens*. Brouard and Grandperrin (1985) gave the following table (Table 2.1.4) and notes for the Von Bertalanffy parameters, total mortality index (Z) and natural mortality index (M) for six major species of the outer reef slope in Vanuatu.

Table 17: Some biological parameters for six major species of the outer reef slope in Vanuatu.

		Mean growth (cm/year)							
Species	K	L_∞ (cm)	30<L<40	40<L<50	mean L(cm)	Lc (cm)	$Z_1(a^{-1})$	Z_2 (a^{-1})	$M(a^{-1})$
E. car	0.07	94	4.2	3.42	57	28	0.07	0.089	0.149
E. cor	0.128	82	5.99	4.71	55	30	0.107	0.136	0.237
L. mala	0.310	60	7.65	4.47	44	32	0.447	0.401	0.545
P. flav	0.356	58	8.06	4.39	35	27	0.648	1.006	0.602
P. fila	0.295	60	7.28	4.26	41	31	0.467	0.587	0.527
P. mult	0.244	64	7.01	4.53	44	34	0.375	0.460	0.448

K=1000/W, $W=aLm^b$ (a, b obtained by means of the length/weight relationship; meanL=mean maximum lengths, $Lc=(L_{100}$ +Lo)/2, Z1: total mortality calculated by regression of the Log of the number of individuals as a function of time, Z2: K ($L\infty$-meanL)/meanL -Lc), M: natural mortality expressed by the equation LogM=-0.0066-0.279 log$L\infty$+0.6543 logk+0.4634 logT.

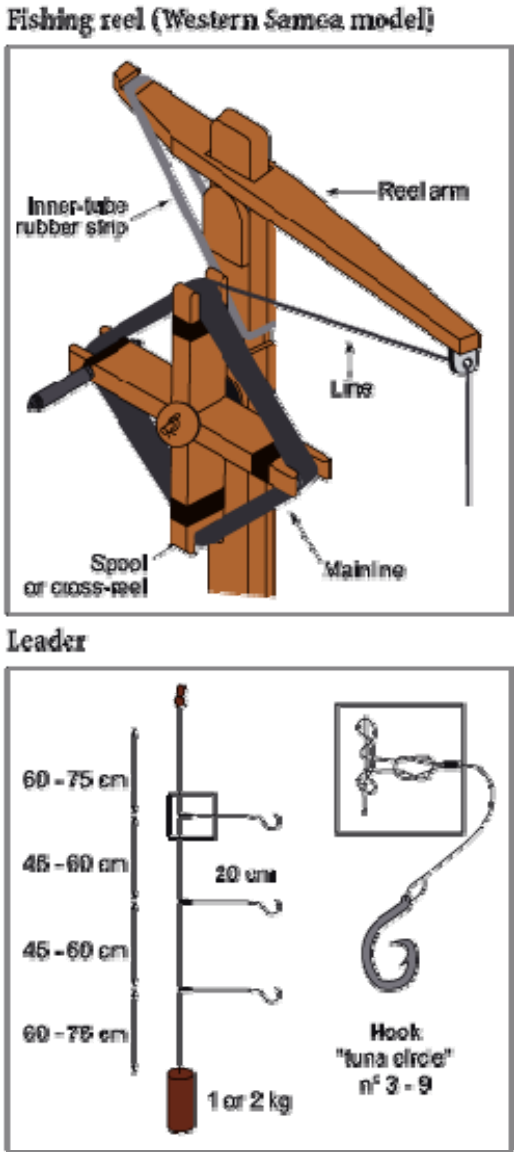
Carlot (1988) estimated growth and mortality parameters (L_∞ and K) of *E. carbunculus* in Vanuatu to be 132.4 cm and 0.22 $year^{-1}$ respectively using ELEFAN I. Brouard and Grandperrin (1985) estimated the same parameters for the same species, using otoliths, to be 94.0 and 0.07^{-1} respectively. Length-weight relationships for some species are given in Appendix 2.1 (b).

11.1.2 The Fishery

11.1.2.1 Fishing Technique

Until the late 1980s, most fishing was done with a manual wooden reel, monofilament line fitted with a metal leader, three hooks and a weight, as shown on the diagram below:

Figure 1:Type of fishing gear used for catching deep bottom fish



The manual wooden fishing reel is a home-made device developed by FAO* in 1976 which has been widely adopted in the Pacific Islands (Guldbransen, 1977). In Vanuatu, this device has replaced the bicycle pedal mechanism and is generally used on powerboats, but sometimes also on traditional dugout canoes. The fishing line on these reels is used for trolling and deep-sea fishing. In this latter case, it descends vertically from the fishing boat with the motor off. Three hooks set at about 50 cm intervals are baited with skipjack tuna or sardines. The line is only fitted with a small weight as it remains in the water for a very short amount of time.

Food and Agriculture Organization of the United Nations.

This fishing is undertaken during the day or at night, usually drifting - very little deepwater mooring with a grab anchor was practised (Guldbransen, 1977; Crossland & Grandperrin, 1980). Deep long-line fishing was only a marginal technique until the 1990s when it was gradually adopted by independent fishermen and some associations. Reel and lines are also used for troll fishing, mainly for tuna, around FADs and on the way to deep-sea fishing grounds. Fishing trips are rarely longer than 2 days, and most are less than 12 h long.

Harvey single-hull boat with two rear-mounted fishing reels

Experimental longline fishing expeditions

11.1.2.2 Utilization

The deep-water bottom-fish fishery targets the high commercial-valued snappers ("poulet" - chicken fish) which are locally sold to the fish market, hotels and restaurants. Some enter the subsistence economy at the village level (Dalzell, 1992).

The first datasets available on deep sea fishing were obtained in the South Pacific Commission (SPC) exploratory expeditions in Vanuatu (Humes, 1975, 1976; Fusimalohi, 1979). The initial surveys by the SPC Deep Sea Fisheries development Project between 1974 and 1981 concluded that the deepwater bottom fish resource was virtually unexploited. In 1981, after the formally structured Fisheries Department was set up, the Village Fisheries Development Programme (VFDP) was launched to promote the intensive development of small-scale deep-sea fishing. The hand-reel, developed for deep-water bottom handling in Western Samoa, were used, and were mounted on 8 m catamarans or 5 m dories powered by 25 hp outboard motors. The trial fishing for bottom-fish initiated by SPC, were continued by the Fisheries Department from 1981 to 1982.

The fishing trials using several boat types of catamarans and mono-hulls, the 8.6 m Alia catamaran, 5.0 m and 5.6 m Hartley half cabin launch were chosen, with a marked preference for the Hartley type (Schaan *et al*, 1987**)**.

Fishermens' association boat

Trapping fishing using the Z-type of traps were tried by the Fisheries Department between 1987 and 1988. Results were mostly poor catches with only very few traps making good catches (Guerin, 1989).

The interest generated from the trials and the government's desire to promote the exploitation of the deep-water resources initiated the establishment of the Village Fisheries Development Project

(VFDP) by the Fisheries Department in 1982. This soon led to the creation of more than 200 fishermens' associations throughout the archipelago. The activities of 119 of these associations were monitored* by VFDP and ORSTOM to determine their fisheries potential and management parameters. The geographical distribution and temporal development patterns of the studied associations clearly reflect the patterns of all of the fishermens' associations, and the length of time these associations lasted was found to vary according to the island.

By 1988, a total of 180 fishing projects were registered under the VFDP, although not all of these were directly involved in fishing but concentrated on marketing instead and 10 ice machine centers were established at the following locations: Panita, (Tongoa); Lamen Bay, (Epi); Liro, (Paama); Lamap, (Malekula); Graig Cove, (Ambrym); Lakatoro, (Malekula); Tenmaru, (Malekula); Lolowai, (Ambae); Abwatuntora, (Pentecost); and Waisisi, (Tanna).

Catching a small red snapper by reel fishing

Landing fish before weighing and measuring their length

Following the completion of the EU funded Fisheries Extension Project in 1995 the ice machines centers due to lack operational funds were unable to be sustained. In 1996, all the ice machines centers managed by the Fisheries Department were placed on public tender as a privatization scheme. By 1998 no more ice machine centers were operational, resulting in winding up of a lot of artisanal fishing projects. The closing down of all ice machine centers affected rural sector production of the deepwater fish and reduce almost to zero in some areas rural economy turnover based on fishery products, major one being the deep bottom fish resources. For areas such as Tanna, Efate and Santo where access to local markets and preservation facilities is available, fishing projects were not affected that much.

In 2000, the Government through a policy decision agreed to reactivate commercial rural fishing activities through development of provincial ice machine centers as a mean to boost rural sector economic development. The Fisheries Department through its Development and Capture Division re-established a community-base ice machine project in 2001, funded by the Government of Vanuatu. The project completed its first phase in 2003, which is the establishment of the Tafea (Lenakel, Tanna) and Shefa (Tunika, Emae) provincial ice machine and marketing centers. The aim of the project is to establish an ice machine and fish processing and market center at each Provincial zone.

Duty exemptions privileges are made available to individual fishermen and fishing projects that provided the Fisheries Department with details of fishing activities and catches. Provision of subsidies in-kind by the government, became the incentive that sustained the development of the bottom-fish fishery. A summary of operating projects by area and year, under the VFDP between

1982 and 1986 is given Schaan *et al.* (1989). Tabulated below are the number of provincial artisanal fishing projects that were in operation and provided data to the Fisheries Department between 1982 and 2003:

Table 18: Number of operated fishing projects for 1982 to 2003

Provnce	**82**	**83**	**84**	**85**	**86**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**
TAFEA	1	1	2	2	8	9	9	23	20	14	21	21	22
SHEFA	1	4	6	12	10	33	33	21	17	22	33	29	32
MALAMPA	2	3	3	14	19	23	15	3	3	16	22	17	17
PENAMA	0	0	5	8	11	2	0	0	0	8	10	2	4
SANMA	2	2	5	15	17	15	19	34	33	16	16	8	13
TORBA	0	0	0	1	3	1	3	7	4	1	1	1	1
TOTAL	**6**	**10**	**21**	**52**	**68**	**83**	**79**	**88**	**77**	**77**	**103**	**78**	**89**

11.1.2.3 Production and marketing

Catch rates from various SPC bottom fishing trials in Vanuatu were given in Dalzell and Preston (1992). Based on 80kg/trip and 160 trips/year Crossland (1984) estimated an annual production of 320,000 kg (32 m Vatu) per project.

The advent of the deep-water fishery also established a marketing scheme. Originally, the Natai Fish Market in Vila, operated by a Government owned company called, Port Vila Fisheries Limited, received all of the catches from fishing projects from all over Vanuatu including those based on Efate between 1982 and 1997.

Transportation to Vila was all by air using large coolers, fish boxes and fish bags. Due to increased production a second marketing operation, Santofish, was established in 1983 at Luganville which absorb fish caught in the east coast of Santo (largest fishing grounds) and other outer islands.

Fisheries Extension Centres on the outer islands (seven - one each on Tongoa/Sheperd, Malekula/Lakatoro, Banks/Sola, Ambae/Lolowai, Epi, Santo and Efate/Tafea) purchased and re-sold fish between 1987 and 1993. On Santo and Efate, fisheries extension centres do not deal with purchases and sales of fish as they are handled by Santofish and Natai respectively.

However, because of better prices offered, bottom-fish increasingly went directly to the restaurants and supermarkets in Vila. The total catch (kg) landed and the average catch per trip (kg - in brackets), by area and year, under the VFDP fishing operation between 1982 and 1986 is recorded below (adapted from Schaan *et al*, 1987):

Table 19: Catch per trip for the years 1982 - 1986

Area	**1982**	**1983**	**1984**	**1985**	**1986**		**Area**	**1982**	**1983**	**1984**	**1985**	**1986**
Tanna	1,540	1,165	2,867	3,883	13,547		Malekula	416	5,514	502	6,648	15,646
(C/trip)	(45.3)	(35.3)	(33.7)	(39.2)	(33.1)		(C/trip)	(23.1)	(35.3)	(31.4)	(27.2)	(30.6)
Efate	-	-	4,021	11,212	5,593		Santo	399	16,936	5,935	22,716	16,154
(C/trip)	-	-	(45.7)	(40.3)	(40.5)		(C/trip)	(20.0)	(22.9)	(27.0)	(35.1)	(26.4)
Tongoa	-	-	6,874	6,323	1,010		Pentecost	-	1,883	3,040	6,950	2,315
(C/trip)	-	-	(44.6)	(40.0)	(36.1)		(C/trip)	-	(12.6)	(27.1)	(30.2)	(21.1)
Epi	4,412	6,481	8,219	2,082	2,093		Ambae	-	663	8,508	5,587	4,696
(C/trip)	(33.9)	(38.6)	(39.3)	(32.5)	(30.3)		(C/trip)	-	(30.1)	(23.6)	(19.9)	(21.3)
Paama	2,981	11,895	6,314	10,118	7,059		Banks-Torres	-	-	-	328	1,469
(C/trip)	(69.3)	(43.6)	(29.0)	(28.8)	(27.7)		(C/trip)	-	-	-	(41.0)	(24.5)

Ambrym	-	-	3,515	7,033	4,383		Vanuatu	9,658	44,177	49,795	82,501	73,965
(C/trip)	-	-	(41.8)	(27.9)	(20.1)		(C/trip)	(39.7)	(28.9)	(32.2)	(31.6)	(28.4)

Return from a good fishing trip

During a single fishing trip,
a fisherman may fish at different depths,
so catches are very diversified

Catch of big red snapper
(Etelis carbunculus)

In an attempt to estimate production of the bottom-fish fishery in Vanuatu by species, Schaan *et al* (1987) established a length/weight correlation for the main 11 species of which length data were collected. This was used to estimate weight, by species, of those landed under the VFDP between 1982-1986 and was presented by Schaan *et al* (1987) as follows:

Table 20: Estimated weight by species

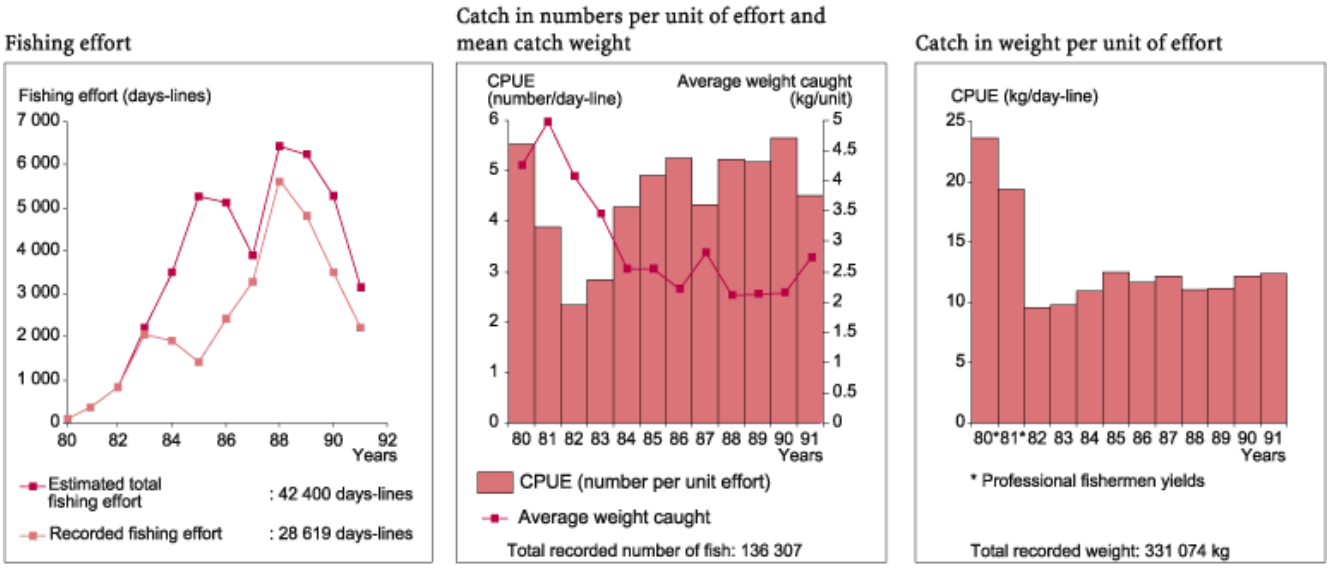
Species	**Est. Weight (Kg)**	**% by weight**	**# Measured**	**% by Number**
L. malabaricus	4,224	5.7	3,720	8.6
E. carbunculus	13,639	18.4	4,635	10.8
E. coruscans	8,550	11.5	2,992	6.9
E. radiosus	2,218	3.0	791	1.8
P. filamentosus	3,671	4.9	2,556	5.9
P. flavipinnis	3,978	5.4	4,940	11.4
P. multidens	10,938	14.7	7,924	18.4
A. rutilans	917	1.2	301	0.9
E. magniscuttis	1,715	2.3	742	1.7
E. morrhua	1,573	2.1	904	2.1
E. septemfasciatus	1,532	2.1	414	1.0
Sub-total	52,955	71.3	29,919	69.5
Others	21,320	28.7	13,131	30.5
Total	**74,275**	**100**	**43,050**	**100**

Cillaurren (1988) estimated the bottom-fish production around Efate in 1988 to be 48,800 kg. The maximum sustainable yield for Efate was estimated to be 98,000 kg, thus the catch represent only 50% of the total potential production from the area.

Annual patterns concerning the fishing effort, yields (total catch weights and fish numbers), and mean catches are presented in Figures 2 below. As of 1983, there was a steady rise in the overall

fishing effort, as shown by the regular increase in the number of fishermens' associations. As of 1989, this trend was reversed, as there were too many associations for the market volume and local outlet potential. Many associations were therefore disbanded due to a lack of sufficient income.

Figure 2: Annual overall fishing effort, catch patterns per unit of effort and mean weight from 1980-1991



11.1.2.4 Deep Bottom Fish production by Fisheries Department Extension Centers (1990 – 1992)

Fisheries Department Extension centers at the time of their operations played a significant role purchasing of deepwater fish from fishermen. Most of the fish bought from fishermen were re-sold with surpluses being freighted to either Santofish or Natai Fish market in Port Vila. Combined catch landings at the Fisheries Extensions from 1990 to 1992 by species are given in Table 21 below (figures in kg - source Fisheries Department data base).

Table 21. Deep-water bottomfish landed (kg) at all the outer islands Fisheries Extensions.

Species	**1990**	**1991**	**1992**
E. carbunculus	1,586.8	1,892.2	1,845.0
E. coruscans	1,733.3	1,562.2	3,322.7
E. radiosus	157.7	413.6	518.3
P. multidens	557.7	55.2	1,884.7
P. flavipinnis	81.1	168.6	805.3
P. filamentosus	1,492.1	3,321.6	9,810.9
L. malabaricus	909.2	1,346.8	3,695.1
A. rutilans	49.5	67.8	601.6
S. rivoliana	229.2	546.0	1,119.8
E. magniscuttis	325.9	270.6	1,067.0
E. morrhua	116.4	279.2	363.1
E. septemfasciatus	252.8	118.4	264.9
Total	**7,491.7**	**10,042.2**	**25,298.4**

11.1.2.5 Sale of Deepwater fish through Natai Fish Market (1988 – 1992)

All of the deep-water bottomfish purchased by the Natai fish market between 1988 and 1992 are recorded in Table 22. Weights are in kg and Value in Vatu. (Source: Fisheries Department Database).

Table 22: Natai Fishmarket Deep-water fish purchases (kg) between 1988 and 1992.

Species	**1988**	**1989**	**1990**	**1991**	**1992**
	Weight	Weight	Weight	Weight	Weight
Poulet	29,138.6	26,867.3	25,779.4	34,194.3	31,551.6

(Value VT)	6,255,248	7,122,309	7,442,506	10,571,647	10,065,338
Sea perch	5,054.3	2,671.6	2,355.5	8,283.0	2,355.5
(Value)	967,100	843,992	938,523	2,429,147	938,523
Loche	4,097.1	3,077.2	2,031.5	3,186.8	2,031.5
(Value VT)	774,296	648,618	516,554	768,463	516,554
Amberjack	1,677.1	1,033.9	1,433.6	938.7	1,433.6
(Value VT)	231,128	154,304	224,781	180,943	224,781
Bream	5,597.9	2,301.1	3,155.7	2,800.6	3,155.7
(Valu VT)	676,283	449,911	611,644	665,062	611,644
Jobfish	1,538.0	210.0	270.1	450.0	270.1
(Value VT)	125,882	40,752	65,482	100,314	65,482
Total Wt	**47,103.0**	**36,161.1**	**35,025.8**	**49,853.4**	**40,798.0**
(Value VT)	**9,029,937**	**9,259,886**	**9,799,490**	**14,715,576**	**12,422,322**

11.1.2.6 Sale of Deepwater fish through Santo Fish Market (1989 – 1992)

Sales of bottom-fish through Santofish from 1989 to 1992 are summarized in the following table (weights in kg). (Source: Santofish Database):

Table 23. Sales of bottom fish through Santofish from 1989 to 1992

Species	**1989**	**1990**	**1991**	**1992**	**Total**
Poulet[5]	28,247.9	29,626.6	34,180.4	27,033.0	**119,087.9**
Snapper	5,274.8	8,214.5	10,035.2	20,276.3	**43,800.8**
Bream	2,058.6	3,700.8	3,078.3	1,121.5	**9,959.2**
Loche	2,708.0	3,228.9	3,520.8	2,431.1	**11,888.8**
A/Jack	1,081.4	2,163.5	1,513.0	1,270.9	**6,028.8**
GJ Fish	152.9	330.6	369.4	159.5	**1,012.6**
Red Emp	85.0	90.8	57.6	44.2	**277.6**
Total	**39,608.6**	**47,355.9**	**52,754.7**	**52,336.5**	**192,055.7**

Summarized in the table below are deep bottom fish production data by provincial fishing projects utilizing duty free fuel between 1993 and 1999. Weights are in kg and Value in Vatu. (Source: Fisheries Department GRN Database).

Table 24. Deep bottom fish production by Province

Year	**Tafea**	**Shefa**	**Malampa**	**Sanma**	**Penama**	**Torba**	**Total**	**Value**
1993	3,205.30	33,308.15	19,772.50	no data submitted	4,346.10	678.20	**61,310.25**	**8,296,930**
1994	7,063.00	26,563.10	5,814.10	no data collected	1,681.70	no data submitted	**41,121.90**	**10,563,363**
1995	5,691.10	23,477.30	11,670.40	no data submitted	4,714.55	no data submitted	**45,553.35**	**10,958,750**
1996	4,730.68	34,982.60	7,087.50	20,608.00	2,494.20	2,352.00	**72,254.98**	**18,993,237**
1997	5,886.20	30,467.54	5,285.88	19,198.45	526.90	744.50	**62,109.47**	**17,000,425**
1998	146.50	13,375.80	925.30	6,562.10	1,204.50	435.00	**22,667.20**	**6,396,996**
1999	no data submitted	13,683.65	655.65	4,838.80	no data submitted	no data submitted	**19,178.10**	**6,156,521**
Total	**28,804.78**	**211,549.79**	**74,661.93**	**51,207.35**	**25,198.25**	**10,453.90**	**324,195.25**	**78,366,222**

Because of the fact that excess fish are sent to Natai fish market in Vila from Santofish and Fisheries Extension Centres, there is a possibility of duplication of data if the sets are combined to obtain the actual total landings using these three sources.

Purchases of poulet fish by Bon Marche, Vila, in 1992 indicated that 3,000 kg were received from Santo, 800 kg from North Efate (Lelepa) and 45 kg / week for 3 months (thus 550 kg) from one Efate fisherman. This amounts to 4,350 kg for that year.

[5]Note: Poulet = *Etelis* and *Pristipomoides*, Snapper = *L. malabaricus*, sea perch, Bream = *Paracaesio*, Loche = *Epinephelus* (especially, *E. septemfasciatus, E. morrhua* and *E. malgaiscuttis*), A/jack = amber jack, GJ fish = gray jobfish, Red emp = *Lutjanus sebae*

11.1.2.7 Exports of deepwater bottom fish

In 1996 an export market was established which resulted in exports of deepwater bottom fish overseas. Summarized below are quantities of poulet fish exported from Vanuatu.

Table 25. Quantities of poulet fish exported from 1996 to 2003

Year	Total Quantity (kg)	Value (VT)
1996	635	136,269
1997	75	225,000
1999	4,818	3,264,416
2001	6,685	4,369,075
2003	5,273	3,244,200

(Source: Fishries Department Export Permits).

11.1.2.8 GRN Catch Sales Records

Summarized below are records of deepwater bottom fish caught by fishing projects and sold at the domestic market for the years 2000, 2001, 2002 and 2003.

Table 26. GRN Catch sales records of deepwater bottom fish for the 2000

Species	Total quantity (kg)	Value (VT)
Amberjack	679	473,300
Loche (*Ephinelus spp*)	1,583	791,500
Large eye bream	6,359	3,179,500
Green Jobfish	933	466,500
Red Jobfish	438	306,600
Short tail poulet	12,460	8,722,000
Long tail poulet	6,351	4,445,700
Other sp	4,584	2,292,000
TOTAL	**34,324**	**21,145,600**

Table 27. GRN Catch sales records of deepwater bottom fish for 2001

Species	Total Quantity (kg)
Long tail poulet	4,055
Short tail poulet	3,086
Large eye bream	203
Stripped bream	257
Loche	974
Red Jobfish	101
Amberjack	420
Othersp	123
TOTAL	**9,219**

Table 28. GRN Catch sales records of deepwater bottom fish for the 2002

Species	Total quantity (kg)	Value (VT)
Amberjack	18	5,430
Bm. Striped Loche	4	1,300
Kusakars Snapper	3	900
Large eye bream	34	10,200
Large Scaled Jobfish	27	12,150
Short tail poulet	203	86,000
Red silver jaw	54	14,110
Sea perch	28	8,400
Spotted Loche	51	15,150
TOTAL	**1,373**	**484,020**

Table 29. GRN Catch sales records deepwater bottom fish for the 2003

Species	Total quantity (kg)	Value (VT)
Amberjack	281	100,270
Bm. Striped Loche	112	35,950
Kusakars Snapper	18.5	7,000
Large eye bream	455	142,310
Large Scaled Jobfish	270	145,445
Pink tail Jobfish	279	125,650
Red Short tail poulet	3,627	1,568,635
Red Long tail poulet	2,321	907,626
Red silver jaw	944	456,720
Silver jaw	22	9,670
Sea perch	357	130,370
Spotted Loche	229	77,565
Seven banded Loche	46	18,015
Stripped bream	7.5	3,000
White poulet	92	18,000
Yellow Jobfish	679	232,968
TOTAL	**21,836**	**7,334,197**

11.1.3 Stocks Status

Eleven species belonging to two families, i.e. red snappers or *Lutjanidae* and groupers or *Serranidae*, account for more than 80% of the fisheries production of Vanuatu. Almost half of the production identified are *Etelis* spp., a third are *Pristipomoides* spp., and the rest includes *Epinephelus* spp., *Lutjanus malabaricus* and *Aphareus rutilans*. The mean sizes are represented by modal lengths determined during experimental fishing trips (Brouard & Grandperrin, 1984). Village fisheries catch sizes range from 20 to 100 cm for *Etelis* spp., and *Aphareus rutilans* spp. (jobfish), from 16 to 120 cm for *Epinephelus*, and 25-80 cm for *Pristipomoides* spp. and *Lutjanus malabaricus*. Some quite large fish were recorded for some species like *Etelis carbunculus.*

The vertical distribution of the fishing effort shows two peaks located between 150 and 200 m and between 250 and 300 m depths, with a subsequent sharp decline to a minimum at around 400 m. Fishing yields (weight) increase steadily from the surface to reach a maximum at 400 m depth. There is almost no fishing effort below 500 m depth.

The vertical distribution of fish species shows clear habitat stratification. *Pristipomoides* spp. and *Lutjanus malabaricus* inhabit the water layer between 25 m and 300 m depth. *Etelis* spp. are the main fish caught below 200 m depth, and *E. carbunculus* is caught at the deepest levels. Groupers (*Epinephelus* spp.) and *Aphareus rutilans* are the most common species in the intermediate waters between 100 and 350 m depth–these fish do not seem to be very depth-specific.

Two groups of species are the main targets of fishermen, i.e. *Pristipomoides* spp. and *Lutjanus malabaricus* within the 100-250 m layer, and *Etelis* spp. in the 200-400 m layer. These species seem to be much more gregarious than *Epinephelus* spp., which are considered to be solitary territorial fish (Moffit, 1993). Groupers seem to be bottom feeders and *Lutjanidae* species can also seek food close to the seabed. For all bottom fish species, larval and juvenile forms are pelagic preferentially colonizing coastal waters, and nycthemerally migrate vertically – surfacing only at night (Parrisch, 1987).

The vertical fishing effort distribution patterns differed little between the islands. Generally, the highest fishing yields do not correspond to maximum fishing efforts. The most commonly caught species (*Etelis* spp. and *Pristipomoides* spp.) are found around all of the islands. A few trends were noted in the catches: *Etelis* spp. are preferential targets in the eastern part of the archipelago, and there is higher *Pristipomoides* production in the western and southern sectors. Note also that *Lutjanus malabaricus* had almost completely disappeared in southern Vanuatu.

Cillaurren (undated) estimated that 74% of the 1987-88 catch comprised of the *Etelis* and *Pristipomoides* species, and that species composition in the 1987 landings showed that 18.2% were of *E. carbunculus*, 14.3% *E. coruscans*, 26.4% *P. multidens* and 15.3% *P. flavippinis*. No significant change was observed for the 1988 catch except that percentage composition of *P. flavippinis* decreased to 6.9. The catch production around Efate, with seven operating fishing vessels, landed about 48,800 kg, only about 50% of the estimated annual potential production of 98,200 kg around Efate. This study however, did not take into consideration length frequencies analysis.

Examination of catch data for the 1982-88 period for catch and effort analysis for the fishery and length frequency analysis on the four most commonly caught deep-water snapper species, *E. carbunculus*, *E. coruscans*, *E. radiosus* and *L. malabaricus* is reported in Carlot and N'Guyen (1989). The results indicated that, overall, the CPUE (catch per unit of effort) generally declined slightly as the number of boats increased. The CPUE's for some specific locations however, remained about the same except for a marked decline detected for the Paama area. The authors showed that the overall relationship between catch and effort gave little or no curvature even at the highest level. The exploitation rate, E, was calculated to be 0.26 which suggested moderate exploitation of the stocks of these species, given limitation of the data. Examination of the data also indicated evidence of decline in both the mean length and the 95 percentile. The authors concluded that their results appeared to be consistent with the conclusion that the stocks were at that time under-exploited.

The same authors calculated Optimum fleet size for the bottom-fish fishery in Vanuatu using two methods, those of Gulland 1971 and Pauly 1984. The Gulland method yielded optimal fleet size to be 138 vessels while that of Pauly gave 55 vessels. Based on different assumptions and calculation, Brouard and Grandperrin (1985), estimated that 120 boats might generate the Maximum Sustainable Yield (MSY).

Most recent and accurate MSY for the whole of the archipelago is provided by Cillaurren, David, and Grandperrin (2001). The authors estimated a total MSY deep bottom fish for Vanuatu to be 535 tonnes per year. Fishing zone estimated to be between 100 – 500 meters. Calculations of the CPUE and MSY are based on catch data for the period 1981 – 1991. Summary of the estimates are provided in the table below.

Table 30: Estimated MSYs

Island	**Estimated 100 – 500 m isobath surface area (ha)**	**CPUE (kg/day-line)**	**Estimated Maximum Sustainable Yield (tones per year)**
Torres	34,286	13.6	21
Banks	66,122	20.0	40
Maewo	25,277	<12.0	15
Ambae	18,525	<12.0	11
Pentecost	30,644	<12.0	19
Santo	152,528	12 - 26	92
Malekula	135,851	15	82
Ambrym	72,305	15	44
Paama	Total for Paama, Epi, Emae & Shepherd Islands is 171,700	No estimate	13
Epi		No estimate	56
Emae		No estimate	25
Shepherd islands		No estimate	9
Efate	117,456	9 – 13	71
Erromango	53,658	No estimate	54
Tanna & Aniwa	61,914	16	37
Aneityum	14,816	No estimate	15

11.1.4 Management

The MSY figures are rough estimates. However, they should nevertheless assist development planners in choosing their objectives. The bottom-fish resources of the outer reef slope are, as it turns out, rather limited, which means that the fishery must be managed with great care.

The growth rates of the main commercial species are fairly low but comparatively higher for the shallow and intermediate species (*Pristipomoides* spp.) than for the deep species (*Etelis* spp.) and that the depth stratification of the species corresponds to a stratification in their vulnerability to intensive fishing" and because analysis was done on virtually virgin stocks, very large-sized, therefore very old, *Etelis* are frequently caught. If fishing pressure were to be increased significantly, it is very likely that these large specimens will disappear. From both the catch and effort and length frequency analysis there is evidence to suggest that the fishery is still under exploited though there are slight declines both in mean length and the larger fish (the 95 percentile) and also in the CPUE for each island.

The fact that the relationship between catch and effort for the whole country suggests that there is room for more effort caution should be taken, as there might be some locations where the effort has reached its optimum level.

The change in marketing strategies has made it harder to collect accurate data consistently. Thus tracing the trends in the fishery using only catch landings from the private sector would require an improvement of the current data collecting system to include those sold to stores and restaurants. Even though exploitation seems to be moderate currently, small specimens (6-8") of *Pristipomoides* were seen being offered for sale in one supermarket in Vila that was visited. Brouard and Grandperrin (1985) noted that some species were being caught before they reach sexual maturity if 45 cm was taken as the full recruitment length and would thus be sensitive to fishing pressure. However, the smaller species are not recruited into the fishery until they are well above their sexual maturity size.

There are indications that the interest and involvement of the private sector in this particular fishery is levelling off or even declining due to the lack of government support and limited local market. It has been noted that fishermen in Vanuatu can be so easily tempted away from the sea that it must be ensured that there is a ready supply of inputs to fishermen (MacAlister Elliott & Partners, 1992). Overall this could indicate the trends in profitability of fishing for the fishery when either the resource or the market, or both, are limited. The local market alone limits the fleet number that can economically operate within the fishery.

11.1.4.1 Current legislation/policy regarding exploitation:

There is currently no legislation that specifically controls the exploitation of the deep-water demersal fishery. However, current government policy reserves the exploitation of this resource only for local fishing enterprises owned by citizens and natural citizens of Vanuatu

11.1.4.2 Recommended legislation/policy regarding exploitation:

Given the commercial value of this resource and the need for sustainable utilization, the Fisheries Department should develop a management plan for the deep-water demersal fishery which should place a limit on boat numbers and quotas in specific fishing areas (grounds) within Vanuatu.

In order to give the management plan legal back up, the Minister responsible for fisheries sector using powers accorded under the Fisheries Act make regulations which impose number of fishing crafts, fishing gears, size of hooks and provincial demersal fishery quotas based on calculated MSYs.

Appendix 1.

The different stages in the sexual maturation scale as recorded by Brouard *et al* (1985):

Stage	Males	Females
1	Indeterminate sex	Indeterminate sex.
2	Gonad poorly developed, long and thin; translucid; whitish to pinkish in colour	Gonad poorly developed but rather thicker than a mere filament; translucid; slight vascularization.
3	Flattish testicle; pinkish white colour; does not run after cutting	Opague ovary with strong vascularization ranging from pink to red; oocytes not visible to the naked eye.
4	Thick testicle, white; runs slightly after cutting.	Well developed ovary with strong vascularization colouring yellow to dark red; transparent membrane; granulous appearance; oocytes visible to the naked eye.
5	Thick testicle; often with a triangular section; curdled milk appearance; white colouring, runs easily after cutting.	Swollen and granulous ovary with very thin and fragile membrane.
6	Running ripe	Running ripe
7	Flaccid testicle, spent and burgundy strong vascularization.	Spent ovary with strong vascularization; red colour, early in this isolation oocytes can still found after cutting.

Appendix 2

Length-weight relationships for some deep-water bottomfish species as calculated by Brouard *et al* (1985). $W = aFL^b$ where FL is the fork length in cm, and W is weight in grams.

Species	a	b
Aphareus rutilans	0.00336	3.311
Aprion virescens	0.00345	3.330
Epinephelus areolatus	0.13556	2.327
E. magniscuttis	0.03916	2.754
E. morrhua	0.06058	2.624
E. septemfasciatus	0.00332	3.348
Etelis carbunculus	0.02161	2.950
E. coruscans	0.04105	2.758
Gnathodentex mossambicus	0.04012	2.824
Lethrinus miniatus	0.03293	2.728
L. variegatus	0.18224	2.284
Lutjanus argentimaculatus	0.00540	3.206
L. bohar	0.00003	4.606
L. gibbus	0.00006	4.646
L. malabaricus	0.00853	3.137
Paracaesio kusakarii	0.01059	3.135
P. stonei	0.19977	2.402
Pristipomoides flavipinnis	0.02991	2.825
P. multidens	0.02003	2.944
P. typus	0.03909	2.733
Seriola rivoliana	0.00636	3.170
Tropidinius argyrogrammicus	0.00976	3.221
T. zonatus	2.50119	1.612

11.2 TUNAS

11.2.1 The Resource

Species present:
The important commercial species in the local tuna fishery include, skipjack (*Katsuwonus pelamis*), yellowfin tuna (*Thunnus albacares*), mackerel tuna (*Euthynnus affinis*), dog-tooth tuna (*Gymnosarda unicolor*), and albacore (*Thunnus alulunga*). Big-eye (*T. obesus*) and frigate tuna (*Auxis thazard*) have also been recorded.

11.2.1.1 Distribution

The tunas found in Vanuatu are generally believed to migrate throughout the region at various times of the year. This means that the same fish found in Vanuatu may, depending on the season, also be found in the waters of other Pacific countries, such as the Solomon Islands, Fiji and Australia, as well as in the high seas. The stocks are therefore regional tuna stocks rather than belonging to any one country. Distribution of the tunas is summarized as follows:

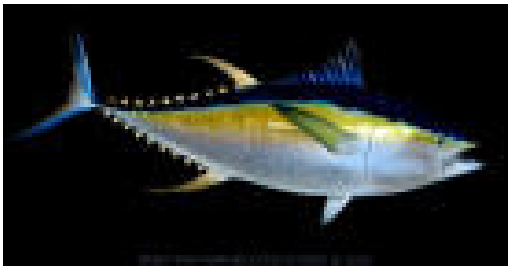
Skipjack tuna:

Skipjack tuna exhibit a strong tendency to school in surface waters and are abundant and widely distributed throughout oceanic surface waters of the world, except in the Black Sea. Surface-schooling, adult skipjack tuna (>40 cm fork length, FL) are commonly found in tropical and subtropical waters of the Pacific Ocean. Skipjack in the WCPO are considered a single stock for assessment purposes.

In the western Pacific, warm, poleward-flowing currents near northern Japan and southern Australia extend their distribution to 40ºN and 40ºS. These limits roughly correspond to the 20ºC surface isotherm.

A substantial amount of information on skipjack migration and movement is available from tagging programmes. In general, skipjack movement is predominantly east to west in the WCPO but highly variable due to environmental events. During the warm El Niño events, the warm pool (oceanic area with sea surface temperature >28ºC) and part of the skipjack stock are displaced eastward towards the Marshall islands, Nauru and Kiribati EEZs. Conversely, during La Niña or cool events the warm pool compresses and skipjack are concentrated towards Papua New Guinea and the Federated States of Micronesia

Yellowfin tuna



Yellowfin tuna are abundant worldwide in tropical and subtropical seas particularly of the Pacific Ocean. Juveniles commonly school in surface waters in the WCPO with skipjack and to a lesser extent bigeye tuna. Adult yellowfin in the WCPO are located in deeper waters but are usually above the thermocline, a zone of rapidly changing water temperature.

The population ranges from about 40°N-35°S in the western Pacific and 35°N-33°S in the eastern Pacific. Restricted mixing between the western and eastern Pacific based on genetic and tagging Data suggests two stocks in the Pacific. Unlike skipjack, adult yellowfin (>100 cm FL) are found in warm surface waters of the tropical Pacific, as well as in cooler subsurface waters.

Bigeye tuna

Bigeye tuna are distributed worldwide in tropical and temperate seas, but absent from the Mediterranean. Juveniles and small adults may school at the surface with other bigeye or with yellowfin and/or skipjack. Adult bigeye inhabit greater depths than the other tropical tunas and are often associated with the thermocline

Adult bigeye tuna (>100 cm FL) inhabit the tropical and temperate waters of the Pacific Ocean between northern Japan (40°N) and the north of new Zealand (40°S) in the west, and from about 40°N to 30°S in the east, except near waters of Central America between 5° and 20°N. Overall habitat is limited by temperature and dissolved oxygen concentration. Within these limits, food supply is probably the major determinant of distribution.

Albacore tuna

Albacore distribution is quite different to that of the three tropical tunas – skipjack, yellowfin and bigeye. Juveniles concentrate in temperate areas where food is abundant, commonly at the ocean surface along frontal zones. Distribution includes the Mediterranean Sea extending north to 45 to 50° and south to 30 to 40° but not at the surface between 10°N and 10°S.

Mature albacore gradually disperse to the subtropical areas and inhabit deeper waters within the thermocline.

Mackerel tuna

Distribute throughout the warm waters of the Indo-West Pacific including oceanic islands and archipelagos. A few stray specimens have been collected in the eastern tropical Pacific.

Dog-tooth tuna

Dog-tooth tuna inhabits waters of the tropical Indo-West Pacific from the Red Sea and East Africa east to Japan, the Philippines, PNG, and Australia and out into the islands of Oceania.

Frigate tuna

Distribution is probably cosmopolitan in warm waters but there are only a few documented occurrences in the Atlantic Ocean

Skipjack, yellowfin, bigeye and albacore tunas are present year round in Vanuatu waters (Bigelow 2001). Skipjack resource is indeed considerable, given adjacent fisheries in Fiji and the Solomon Islands. Most of Vanuatu waters lie in areas where albacore are more prevalent, that is albacore tunas inhabits cooler waters to the south of 20ºS. Aerial surveys for the surface tunas, conducted by ORSTOM and funded by the Vanuatu Government, between April 1980 and April 1981 spent 250 flying hours (prospecting for tunas). One hundred and ten schools were sighted in different areas with the best areas around Efate accounting for 17.30% of the schools sighted, West Santo 15.5%, East Loyalty 10% and East Tanna and Aneityum 9.1%. The survey indicated no clear seasonal pattern of abundance and distribution in Vanuatu waters except that poor months were April and November.

Most recent and up to date scientific assessment of the status of the stocks is undertaken by fisheries scientists from the Oceanic Fisheries Programme (OFP) of the SPC in Noumea. The

OFP carries out stock assessments and related analysis of highly migratory tuna stocks and publishes results in a number of formats including:

- National Fisheries Assessments for each country;
- The OFP Tuna Fishery Yearbook; and
- The OFP Regional Tuna Bulletin.

Up to date information and publications can also be obtained from the OFP web site at: www.spc.org.nc/oceanfish.

11.2.1.2 Biology and ecology:

Many tuna species migrate considerable distances, swimming continuously. They eat substantial amounts of food and have rapid growth. Many species maintain core body temperatures several degrees above the surrounding sea temperature. Open sea species feed largely on epi-pelagic fishes, squids, and crustaceans. Near-reef species also utilize the larval and early juvenile stages of reef fish and crustaceans as prey. Reef-associated species prey on large zooplankton or fish occupying the water above the reef (Myers, 1991)

Skipjack tuna

Skipjack are common to 80.0 cm FL and weight of 8 to 10 kg. Growth is similar to yellowfin and bigeye tuna in the first year and slower thereafter, although significant differences occur between individuals. Skipjack longevity is about five years as the longest period at liberty for a tagged skipjack 4.5 years. Reproductive maturity is reached at 40-45 cm, corresponding to an age of one year or less.

Skipjack reproduction is especially frequent in an equatorial band between 10°N and 10°S. Spawning has been known to occur in both the western and central Pacific and some extend in the eastern Pacific if the water temperature is >25°C. Spawning occurs throughout the year in equatorial and tropical waters, but only during summer at higher latitudes.

Analysis of data obtained during the SPC (October 1977 to August 1978) assessment indicated that by maturity stage, maturing skipjack dominate female skipjack. Presence of female skipjack with recovering gonads in Vanuatu in December 1977 and January 1978 indicated that annual spawning occurs in Vanuatu waters during the period between December and January. Data suggested that skipjack spawning in Vanuatu waters exhibits seasonal periodicity. Common diet of skipjack in Vanuatu waters include squid, tuna juveniles (several species in the family Scombridae), surgeon fish (Acanthuridae) and the alima stage of stomapods.

Yellowfin tuna

Yellowfin are common to 150 cm FL and are relatively fast growing. Yellowfin tuna attain reproductive maturity at 105 cm probably before the age of two years. Spawning occurs throughout the year within 10 degree of the equator. Spawning is progressively confined to summer months at higher latitudes when the sea surface temperature is >24°C. Spawning usually occurs at night with a mean spawning interval of ~2 days. Reproductively active fish are vulnerable to troll, purse seine and shallow handlines and longlines, whereas deeper longlines catch mature, but reproductively inactive fish.

Tagging studies for the western Pacific indicate extensive movements between 120 degrees East and 170 degrees West longitudes. With distinct stocks in the eastern Pacific and western central Pacific. Juvenile yellowfin often occur in mixed schools with skipjack of the same size but as they grow they begin to inhabit the deeper cooler water. Available data suggest that yellowfin tend to increase in size from west to east.

Bigeye tuna

Bigeye tuna are common to 180 cm FL with a maximum length of over 200 cm. Bigeye are believed to be significantly longer lived relative to yellowfin. Several tagged bigeye have been recaptured in excess of eight years at liberty (the longest period at liberty is currently 8.2 years). These fish were aged between two and three years at release, which suggests that significant

numbers of fish survive at least until ten years of age. Bigeye mature at a size of 100-300 cm probably during their third year of life.

The distribution of bigeye larvae suggests that they spawn in the western Pacific between 30°N and 20°S and in the eastern Pacific between 20°N and the equator. Similar to yellowfin tuna, bigeye spawning occurs at night with a spawning frequency of ~2 days; however, the duration of the spawning season for individual bigeye is not known.

Albacore

Albacore are common between 60 – 100 cm with a maximum length of 130 cm. Growth is relatively slow and lifespan relatively long compared to the three tropical tunas. Albacore grow at a rate of approximately 8 cm per year from ages 2 to 5, with slower growth thereafter. Significant numbers of albacore probably reach an age of 10 years or more and the longest period at liberty for a tagged and recaptured albacore is 11 years.

Albacore reach reproductive maturity by 82 cm, which corresponds to an age of at least five years. In contrast to the tropical tunas, albacore larvae are rare in the equatorial Pacific. Adult albacore tuna (>80cm FL) in the south Pacific spawn in tropical and subtropical waters between 10° and 25°S from November to February. The main spawning area for albacore in the South Pacific is at 15-25 degrees South latitude in summer months. Albacore are also found in the North Pacific, though the northern and southern stocks are generally considered to be separate.

Albacore is distributed Pacific-wide with juveniles concentrating in the sub-tropical zone between 35-40 degrees South latitude from East of New Zealand to 130 degrees West. Adults tend to concentrate in the 15 to 30 degrees South latitude band. Vanuatu is within this band.

11.2.2 The Fishery

11.2.2.1 Utilization

11.2.2.1 (a) History of the Vanuatu Tuna Fishery

Foreign and International Involvement

Vanuatu tuna resources are exploited at industrial, artisanal and subsistence level. The following Vanuatu summary is largely based upon the studies of coastal fisheries in the Pacific (Dalzell et al. 1996), and the Vanuatu Tuna Management Plan (Tim Webb 2000).

Since the mid-1950's, commercial fishing for the tuna resource within the EEZ of Vanuatu was exploited by the Taiwanese, Korean and Japanese longliners on a low scale (Wright, 1989). The Japanese longliners were the first but were replaced by the Koreans around 1967 and after 1975 by Taiwanese vessels (Habib, 1984). Albacore was the principal target species for canning in the US, Japan and other countries.

Vanuatu's involvement in commercial tuna fishing commenced in 1957 with the establishment of the South Pacific Fishing Company Limited (SPFC) base at Palekula, Espiritu Santo island in the north of the group. SPFC was established by the Japanese Mitsui & Company, with the objective of conducting tuna transhipment operations of longline vessels. The facilities established at the Palekula Base were large and occupied some 24 hectares of relatively flat land, which had been initially developed by the US Navy during World War II.

The SPFC complex was established in 1957, and consisted of a main wharf, slipways (one 500 GRT and one 50 GRT), cold storage, two bait freezers (5,000 cartons of bait in 10 kg boxes/room), two quick-freeze rooms, unloading area, engine room, large brine block ice makers with crusher, a loading facility, housing and workshops.

In 1974, much of the plant was upgraded, with a new cold storage facility replacing the old. The new cold storage was in three rooms, each holding from 500 to 600 metric tonnes of frozen fish. A new engine room was also installed with three large Yanmar diesels with alternators for power, and four large compressors for the ammonia refrigeration system. The bait freezers and quick-freeze rooms were retained. The ice facility was abandoned with ice made by filling plastic bags with water and placing them in the quick-freeze rooms. A new 'T' section was added out from the existing main wharf, so that larger carrier vessels could come alongside to load. In addition, a new fuelling wharf was put in at this time, which was also used for vessels to tie up to, as well as two large fuel storage tanks and a pump house with pumping equipment.

Over the years, many longliners from different countries worked out of the Palekula Base. Unfortunately, the transhipment side of the base's operation closed in 1986, when the remaining vessels relocated to American Samoa to take advantage of incentives offered by processors there. At this time, the facility was turned over to the Government of the Republic of Vanuatu. The slipways were still operational and the government continued using them until 1998, when financial problems with SPFC caused their closure.

In 1987, a Russian purse-seiner paid a reported USD $1.5 million to access the Vanuatu zone. It only reported a catch of some 12 metric tonnes of tuna during the short period of operation.

Also in 1987, the *Treaty on Fisheries between the Governments of Central Pacific Island States and the Government of the United States of America*, administered by FFA, entered into force. The Treaty allows US purse-seiners licensed under the Treaty to fish in Vanuatu waters. This has only occurred on four occasions, in 1999, with very small catches.

Vanuatu's next major experience with tuna fishing was with the development of a Bilateral Agreement between the Government of the Republic of Vanuatu, through SPFC, and the Kaohsiung Fishermen's Association of Taiwan in 1989. Under this agreement, an unlimited number of vessels could fish in Vanuatu waters, with the license fee set at USD $5,000 per vessel. There were no minimum terms and conditions under this agreement and it is still in force today with varying numbers of vessels taking out licenses annually. The government intends to re-negotiate this agreement to bring it in line with national and international requirements and standards as they apply to Vanuatu.

The mid-1990s saw the establishment of two tuna fishing enterprises, each managing vessels in Vanuatu. The first, International Tuna Services Limited (ITSL), operated two purse-seiners and one longliner. The purse-seiners were Korean, although the vessels were Vanuatu flagged. The company was 51% Vanuatu owned, which at that time allowed the vessels to be licensed as local fishing vessels, with an annual fee of 500,000 Vatu per vessel. Unfortunately in March 2000, low prices for canning-grade tunas world-wide forced these vessels to tie up until the economic climate improved.

The ITSL longliner was Korean flagged and licensed in Vanuatu as a foreign vessel with an annual fee of 500,000 Vatu. This vessel did fish in Vanuatu waters at certain times of the year, and in the EEZ's of other countries at other times. Unfortunately, the longlining operation lasted less than 12 months.

TOHO Vanuatu Limited operated a single freezer tuna longliner, which was Japanese owned and licensed under a trial/experimental arrangement in Vanuatu, paying a fee of 20,000 Vatu/month (240,000 Vatu/year). The operation started in late 1995, doing 20 day trips and landing 15—20 metric tonnes/trip. The vessel transhipped its catch from Noumea, where it also took on fuel and provisions. This venture operated for only 4 months.

During 1999 and 2000, the government negotiated with four Fijian-based companies; Tuna Pacific Agencies Limited and CKR Fisheries Limited having signed agreements for up to 16 vessels each

to fish in Vanuatu waters. The other two companies, Tuna Pacific Company Limited and Jiko Fishing Company Limited, agreements allocated up to 16 vessels each.

The licensing fees for all of the Fijian Companies has been set at USD $8,000 per vessel (license fee of USD $7,000 and observer fee of USD $1,000). The vessels were able to fish in Vanuatu waters and only need to provide entry and exit reports with a faxed copy of the log sheets. All catch is landed to processors back in Fiji. Under the agreements, Vessel Monitoring System (VMS) is required.

Domestic and Locally Based Development

Domestic interest in catching tunas did not begin in Vanuatu until the early 1980s, when the Village Fisheries Development Programme (VFDP) was established under the European Development Fund (EDF) in 1982. Canadian volunteers were involved in the VFDP, setting up commercial fishing enterprises at village level around Vanuatu. The focus was to develop a fishery based on exploiting deep-water snappers, using wooden handreels and boats supplied as part of the project.

A supporting component of the VFDP was the construction and deployment of fish aggregating devices (FADs) in selected areas. The purpose of the FADs was to provide a fishing location where boats could go to catch small tunas, mainly skipjack and juvenile yellowfin tuna, which could be used as bait for fishing deep-water snappers. Several FADs were deployed off Port Vila in late 1982 and early 1983, and the Fisheries Department promoted their use by local fishermen. These FADs were also used by the charter sportfishing vessel operators working out of Port Vila, to increase the potential of catching fish for their paying customers.

Also during 1983, the Fisheries Department, with technical assistance from the then South Pacific Commission, conducted experimental fishing trials around the Port Vila FADs. These trials included the use of vertical longlines, single-hook drifting lines and gillnets, as well as normal trolling techniques. Trolling catches from around the FADs were quite high at 9.0 kg/line-hour, with the occasional lure and fish lost to sharks. Sharks were the main catch from the gill net fishing trials, with the nets being badly damaged.

FADs were deployed in other locations around Vanuatu, in the vicinity of VFDP centres where there were bait shortages and there was a suitable location for deployment. The FADs also provided an alternative protein source to villagers, especially in the rural areas.

As part of the VFDP, two fish markets were established in 1983, one in Port Vila and the other in Luganville. The marketing strategy for the village projects was that each centre would sell catch locally, usually the lower value species, with the higher value species transported to one of these centres for either local or export sale. In fact, it was a requirement of the VFDP that all fish, apart from those sold locally in rural areas, had to be sold to the two government-owned fish markets. The problem with this arrangement was that the two fish markets would not normally purchase tunas, which meant that unless the tunas caught around FADs could be sold locally in the rural areas, there was no market available in the main centres. This marketing approach greatly restricted any development in small-scale tuna fishing.

The use of FADs continued into the 1990s, after the conclusion of the VFDP. The Fisheries Department had materials they had received under the EDF as well as Japanese aid in goods and services. The locations of the FADs were gradually restricted to the two main centres, Port Vila and Luganville. This was due to the dwindling materials available, the lack of funds to purchase new materials, and the fact that the main users were the charter sportfishing operations and some local fishermen in these areas. In fact, the charter sportfishing operators and other small-scale fishermen using the FADs in the mid and late 1990s purchased some of the materials to

complement those still held by the Fisheries Department. The charter sportfishing operators then used their own vessels to deploy several FADs off Port Vila.

In November 1995, Vanuatu Fishing Investments Limited (VFIL) was established as a locally incorporated company owned by New Zealand interests. VFIL's agreement included the leasing of the Port Vila fish market set up under the VFDP (which had been operating at a reduced level for several years) to use for their fishing venture. The fish market was known as Natai. VFIL was required to restore the equipment in Natai (chillers, freezers, ice plants etc.) to an operational condition, plus sell domestic market products including a range of imported seafood products.

VFIL was granted four locally-based foreign fishing licenses at the time of signing the agreement, and had access to another 10 such licenses if required. In July 1996, VFIL had four vessels licensed, although only one actually came to Vanuatu to fish, F/V *Marine Princess* (64 GRT). This vessel was set up for both tuna and demersal longlining, with most trips around 6 days using a mix of both gears. Unfortunately, this venture pulled out of Vanuatu in December 1997. The reasons for this were not clear, however, it is thought to be was a mix of inexperience at fishing in Vanuatu, mixing fishing techniques, low catch rates, and varying prices for both export and domestic sales.

Since the failure of VFIL, no further locally based commercial tuna fishing has taken place. The Natai fish market has been sold to private interests, who bulldozed the premises in early 2000 to build a supermarket with fish display and take-away food sections. However, charter sportfishing operators continue their operations with a great reliance on FADs to increase their fishing prospects for tunas and billfish. In July 2000, there were eight charter sportfishing vessels operating from five different companies in Port Vila, and one vessel working out of Luganville.

11.2.2.1 (b) Recent development of the Vanuatu tuna fishery

Local vessels
Unlike past years, presently, tunas form an important component of the local artisanal and commercial fisheries. Catches are made by trolling mostly around FAD's using small (~5+m in length) outboard powered vessels. Most of the catches are sold locally but skipjack forms the major bait of the deep-bottom fishery for "poulet" (deep-water snappers-*Etelis* and *Pristipomoides* species).

Locally-base foreign
As a trial, the Government through the Department of Fisheries issued in 2003 up to eight locally-base foreign fishing licenses. The licenses expired on October 2004. Seven of the locally-base foreign fishing vessels are of Chinese Taipei origin chartered by a local fishing company known as "Sound Fishing Group". The eighth vessel was a Russian fishing boat chartered by another local fishing company known as "Sushi Fresh". Three of the vessels sunk in Port Vila harbour as a result of a cyclone in 2004, leaving only 5 vessels in operation.

The vessels were allowed to fish up to the 9 nautical miles measured from the Vanuatu base lines. As a condition, the vessels were required to off load all their catch in Vanuatu for re-export over seas and for local consumption.

Foreign Fishing Vessels
The number of foreign fishing activities has increased from 14 in 1999 to 137 in 2003. This increase is a result of Bilateral Fishing Agreements the Government of Vanuatu signed with 9 different foreign fishing companies.

Only one out of the 9 foreign fishing companies has a local agent based in Port Vila, while the other eight fishing companies are based in Fiji. The foreign fishing vessels were licensed by the Department of Fisheries to fish for tuna and tune like species in Vanuatu waters. The vessels were prohibited to fish in the Territorial Waters.

Summarized below are the number of licensed foreign, locally based foreign and local fishing vessels that fished in Vanuatu waters for the period between 1996 and 2003.

Table 31: Number of licensed fishing vessels

Year	Foreign fishing vessels	Locally-base foreign fishing vessels	Local fishing vessels
1996	34	1	7
1997	26	0	1
1998	15	0	3
1999	14	0	4
2000	63	0	9
2001	54	0	6
2002	105	0	6
2003	137	8	9

11.2.2.2 Production and marketing

The Vanuatu-based Taiwanese vessels harvested up to 15,000 tonnes per year fishing in the albacore-rich waters of the open ocean south of Vanuatu and in the EEZs of neighbouring countries. These "longline vessels (and formerly Korean and Japanese) fishing for albacore took only a small portion (500-2,000 tonnes per year during the 1970's) of their catches in Vanuatu waters" (Government of Vanuatu Second National Development Plan, 1987-91). The catch/effort data, including tunas and billfish, between 1962 and 1977 by the Japanese and Taiwanese longliners within Vanuatu fishing zone is given in Skipjack Programme (1981).

Table 32: The combined catch of tunas (in numbers of fish) for 1967 to 1977.

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
B/fin	33	1	1	19	7	26	219	0	14	10	33
Albaco	49,048	30,116	11,390	25,409	33,929	43,421	57,245	10,300	11,550	24,010	30,843
Bigeye	3,349	1,807	865	1,100	2,145	2,127	3,588	1,102	378	2,376	910
Y/fin	7,758	6,176	6,146	4,709	15,931	12,826	18,066	5,473	8244	7,064	6,317
S/jack	148	6	0	20	13	2	18	4	0	164	968
S/tunas		403	404	235	314	0	1	0	0	0	0
Total	**60,303**	**38,509**	**18,806**	**31,492**	**52,339**	**58,402**	**79,137**	**16,879**	**20,186**	**33,624**	**39,071**
$Effort^1$	1,104	475	2	33	143	188	102	14	5	2	1
$Effort^2$	546	493	417	667	1,152	1,271	2,216	772	749	1,305	1,332
$Effort^{1+2}$	1,650	968	419	700	1,295	1,459	2,318	786	754	1,307	1,333
Rate*	36.55	39.78	44.88	44.99	40.42	40.03	34.14	21.47	26.77	25.73	29.31

$Effort^1$: Japanese vessels-effort in thousands of hooks

$Effort^2$: Taiwanese vessels-effort in thousands of hooks

Rate* : Number of fish per thousand hooks - the number of fish is not the total number of fish caught as billfish are excluded. The other portion of the catches comprises billfish reported under the Profile for Other Oceanic Pelagics.

Table 33: Habib (1984) gave the following table for combined catches (tonnes) by Japanese and Taiwanese fleets in Vanuatu waters from 1972 to 1976:

Catch	1972	1973	1974	1975	1976
Albacore	726	925	168	193	493
Yellowfin	420	525	172	211	250
Bigeye	101	164	53	19	132
Other	105	144	39	25	137
Total	**1,352**	**1,758**	**432**	**448**	**1,012**
No. Fishing Days	*737*	*1,144*	*409*	*342*	*798*
Catch per Fishing Day (t)	*1.8*	*1.5*	*1.0*	*1.3*	*1.3*

The Japanese pole-and-line fishing vessels, operating in the 1970's in the northern part of the EEZ, took only modest quantities (300-1,600 tonnes per year) of skipjack **(**Government of Vanuatu Second National Development Plan, 1987-91**)**. The monthly summary catch by the Japanese pole-and-line vessels operation within the Vanuatu's EEZ from 1974 to 1979 is presented in Table 25, below (adapted from Habib, 1984). The data gives a catch range by pole-and-line of about 5 to 8 tonnes per boat day. Skipjack Programme (1980) gave figures for the Japanese pole and line catch/effort within the Vanuatu fishing zone between 1972 and 1978, which were slightly different and is summarised in the same table but marked*.

Table 34: Monthly catches by the Japanese Pole-and-Line Vessels between 1974 and 1979 within Vanuatu's EEZ.

	1974		**1975**		**1976**		**1977**		**1978**		**1979**	
Month	Days	Catch (mt)	Days	Catch (mt)	Days	Catch (mt)	Days	Catch (mt)	Days	Catch (mt)	Days	Catch (mt)
Jan			1	5			2	4	3	18	2	2
Feb			31	147			209	1,321	5	40	9	35
Mar	2	16	9	24			55	271			1	1
Apr			8	58								
Sep			2	4			1	2				
Oct			10	69								
Nov			6	8	1	4					34	279
Dec					13	90					36	338
Total Boat Days	**2**		**67**		**14**		**261**		**8**		**82**	
Total Catch (t)		**16**		**315**		**94**		**1,598**		**58**		**655**
Catch/boat day		**8.0**		**4.7**		**6.7**		**6.1**		**7.3**		**8.0**
Total Boat Days*	1		31		12		134		8			
Total Catch (t)*		14		138		96		697		53		
Catch/boat day*		14.0		4.5		8.0		5.2		6.6		

Landings and number of boats for the SPFC Longline Fleet are presented in Table 35, below. However, these do not reflect the proportion caught in Vanuatu waters nor catch rates.

Table 35: South Pacific Fishing Company (SPFC) Landings by Longline Vessels at Palekula, Espiritu Santo.

Year	**No. of Vessels**	**Albacore**	**Yellowfin**	**Bigeye**	**Others**	**Total (metric tonnes)**	**Total Fish Re-exported (metric tonnes)**	**Value of Re-exports**
1969	24					8,450	*Data not available*	*Data not available*
1970	26					9,240	*Data not available*	*Data not available*
1971	45					13,403	*Data not available*	*Data not available*
1972	55					15,054	*Data not available*	*Data not available*
1973	57					14,310	*Data not available*	*Data not available*
1974	67					12,704	*Data not available*	*Data not available*
1975	46					6,314	*Data not available*	*Data not available*
1976	28					4,956	*Data not available*	*Data not available*
1977	55					10,063	*Data not available*	*Data not available*
1978	48					9,478	**9,182**	**US$ 14,376,143**

1979	50					7,887	**7,724**	**US$ 13,929,587**
1980	53	4,734	1,659	503	407	7,304	**4,523**	**US$ 9,348,498**
1981	27	3,384	858	252	296	5,121	**4,840**	**US$ 9,348,498**
1982	28	2,981	614	193	273	3,876	**3,881**	**688,931,000 VT**
1983	19	4,178	369	204	280	5,030	**4,541**	**794,869,000 VT**
1984	18	3,132	309	173	292	4,050	**3,945**	**710,302,000 VT**
1985	12	3,058	516	222	136	4,032	**3,962**	**760,830,000 VT**
1986	12	829	219	59	79	1,186	**2,492**	**373,494,000 VT**

Quoted in "Lui A.J. Bell and Moses J. Amos (1993) Republic Of Vanuatu Fisheries Resources Profiles, FFA Report 93/49 (Source: Fisheries Department Annual Reports (for 1983, 1984, 1985, 1986, 1987, 1989), Habib (1984), Government of Vanuatu Development Plans (first 1982-1986 and second 1987-1991).

Catches from the trolling trials conducted by the Fisheries Department between September 1980 and April 1982 indicated that skipjack comprised 61%, yellowfin 23% and others 16%. The results of the 1980-81 aerial surveys indicated surface schools to comprise of 40% skipjack, 26 % yellowfin, 13% mixed skipjack/yellowfin, and the rest indeterminate.

The Russian purse-seiners that operated within Vanuatu waters in 1987 claimed to have caught a total of 12 t of tuna. No report was ever submitted to the Government. An access fee of US$1.5 m was paid for the duration of the agreement (Wright, 1989).

All of the tuna catches between by the small-scale fishery during the years 1988 to 1992 were marketed locally. Some of the catch was sold at site of landing with most of the fish being sold to the former Fisheries Extension Centres on islands where they existed and where proper ice and freezer facilities were located, former Santofish and Natai fish markets (now liquidated). In cases of over-supply on the outer islands, the excess fish were sent to the Natai Fish Market in Vila. The tunas landed at the Natai Fish Market as well as those purchased by the Fisheries Extensions between 1988 and 1992 are shown in Table below. Value of fish landed at Natai are also given (figures: weight in kg and Value in Vatu).

Table 36: Value of Fish landed at Natai Fish Market during the period 1988 - 1992

Species/	**1988**	**1989**	**1990**	**1991**	**1992**	**1990**	**1991**	**1992**
Value	Natai	Natai	Natai	Natai	Natai	F.Ext	F.Ext	F.Ext
S/jack	564.7	381.4	669.7	195.9	1,172.5	219.7	1,199.6	3,964.3
Value	32,125	32,746	64,215	19,280	119,861			
Y/fin	1,335.7	2,487.6	2,633.0	274.5	2,122.1	592.1	1,467.6	3,218.0
Value	199,685	372,222	479,990	61,530	503,785			
D/tooth	768.0	478.3	567.7	76.3	268.6	481.7	1,859.2	1,144.1
Value	99,973	68,825	116,813	17,106	45,806			
Albacor						39.2	69	1,227.9
Value								
Total Wt	**2,668.4**	**3,347.3**	**3,870.4**	**546.7**	**3,563.2**	**1,332.7**	**4,595.4**	**9,554.3**
Total Value	**337,783**	**473,793**	**661,018**	**97,916**	**669,452**	No data	No data	No data

The tunas landed at the Natai fish market stabilized around two tonnes per year while those going through the Fisheries Extension Centres had increased tremendously from one tonne in 1990 to almost ten tonnes in 1992.

Summaries of tuna sales, by species, at the Santofish market between 1989 and 1992 are recorded in the table below. An increase is also shown from about half a tonne in 1989 to almost three tonnes in 1992. The table also contains catch by the OFCF fishing trials in southern and eastern coastal areas and around FADs off Santo Island during the 1985-86 period.

Table 37: Summaries of tuna sales by species (kg)

Species	**1985**	**1986**	**1989**	**1990**	**1991**	**1992**
Skipjack	1,109.3	208.5	12.4	219.6	272.8	718.8
Dogtooth	-	-	486.9	666.1	815.6	487.2
Yellowfin	1,212	738	72.7	146.8	256.7	1,740.7

Mackeral tuna	139.8	499.8	8.0	546.8	0.9	0
Total	**2,461**	**1,446**	**580.0**	**1,579.3**	**1,346.0**	**2,946.7**

The total tuna landing in the three outlets was around 16 tonnes for 1992. However, because excess fish from the Santofish market and the Extension Centres are sent to Natai, the actual total figure is probably lower due to duplication of data.

Following the closure of the Fisheries Extension Center operated ice machines in 1995 and the liquidation of both Santo Fish and Natai Fish Markets in 1999 it was difficult for the department of Fisheries to collect accurate data. The closure of the government operated centers and the urban fish markets also affected the operation of a lot of fishing projects. Up to 95% of the fishing projects ceased operating due to lack of preservation facilities in the rural areas and transporation to the unban markets, such as restaurants and hotels. However, from 2000 onwards fishing activities by rural fishing projects began to increase again. Summarized below are figures tuna caught by artisanal fishing projects.

Table 38: Summaries of tuna catch (kg) by species by artisanal fishing projects 2000, 2002 & 2003

Species	**2000**	**2002**	**2003**
Skipjack	1,766	437	2,439
Dogtooth	601.2	79	111
Yellowfin	779.3	197	1,979
Mackeral tuna	-	-	230
Albacore	12	-	6
Total	**3,159**	**713**	**4,765**

The above figues are not representative of total data provided by artisanal fishing projects. The data are only provided by some fishing projects while others did not bother to provide data to the Fisheries Department.

USTreaty Purse seiners

Under the FFA Member Countries' Multilateral Treaty with the United States of America the following tuna catches were recorded in Vanuatu's EEZ by the American Purse-seiners from 1989 to 2004 (Source: Forum Fisheries Agency):

Table39: Catch (metric tones) by USTreaty Purse seiners (1989 – 2004)

Tuna	**89**		**90**		**91**		**92**		**1997**		**1998**	
	Wt	US$	Wt	US$	Wt	US$	Wt	US$	Wt	US$	Wt	US$
S/jack	692		39		0	0	0	0	10.89		0	0
Y/fin	97		0		0	0	0	0	7.26		0	0
Alb					0	0	0	0	0		0	0
Total	**789**		**39**		**0**	**0.00**	**0**	**0.00**	**18.142**	**2,230.99**	**0**	**0.00**

Tuna	**1999**		**2000**		**2001**		**2002**		**2003**		**2004**	
	Wt	US$	Wt	US$	Wt	US$	Wt	US$	Wt	US$	Wt	US$
S/jack	0	0	0	0	271		63.5		0	0	176.5	
Y/fin	0	0	0	0	0		0		0	0	40.7	
Alb	0	0	0	0	0		0		0	0	0	
Total	**0**	**0.00**	**0**	**0.00**	**271**	**35,585.91**	**63.5**	**8,276.03**	**0**	**0.00**	**217.2**	**58,565.16**

Catch in Vanuatu waters by Licensed Foreign Fishing Vessels

Annual catches (metric tones) of albacore (ALB), yellowfin (YFT), bigeye (BET), billfish and skipjack (SKJ) made by distant-water longline and pole-and-line fishing vessels (Japan, Korea and Taiwan) in the Vanuatu EEZ or in the vicinity of the of the Vanuatu EEZ (15°-20°S, 165°-175°E) between 1979 and 2003 is summarized in the tables below.

Table 40: Catch by licensed foreign fishing vessels in Vanuatu waters

	62	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	**75**	**Total**
ALB	1,111	507	848	99	427	622	356	169	231	106	416	728	317	294	**6,231**
YFT	493	213	372	25	106	158	114	99	50	73	148	293	140	137	**2,418**
BET.	96	45	90	5	25	89	36	17	18	13	18	89	53	7	**601**
B/fish	467	270	406	14	82	62	38	6	35	38	41	27	7	10	**1,503**
SKJ	-	-	-	-	-	-	-	-	-	-	-	-	13	148	**161**

Total	**2167**	**1035**	**1716**	**143**	**641**	**931**	**544**	**292**	**334**	**230**	**623**	**1137**	**531**	**595**	***10,914***

	76	**77**	**78**	**79**	**80**	**81**	**82**	**83**	**84**	**85**	**86**	**87**	**88**	**89**	**Total**
ALB.	514	566	1,241	1,107	558	1,057	837	1,006	1,071	423	273	1,751	2,024	947	**13,375**
YFT	166	109	229	339	139	134	105	84	119	87	119	201	468	132	**2,431**
BET	63	36	31	70	32	51	35	21	64	15	14	16	25	22	**495**
B/fish	51	39	46	63	38	71	34	27	48	14	18	26	32	33	**540**
SKJ	87	644	50	446	536	0	0	0	0	0	0	0	0	0	**1,763**
Others	0	0	0	0	0	4	1	3	7	2	0	0	4	1	**22**
Total	**890**	**1394**	**1597**	**2025**	**1330**	**1317**	**1012**	**1140**	**1308**	**541**	**424**	**1994**	**2552**	**1135**	***18,626***

	90	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**Total**
ALB	1,430	630	10	1617	1771	5705	2561	2342	1253	3036	2672	1445	2022	1810	
YFT	153	137		57	308	370	448	340	180	290	466	252	515	791	
BET	30	13		20	31	121	77	51	63	75	82	57	153	211	
B/fish	74	33		30	147	212	94	51	45	132	122	0	0	0	
Others	0	2		0	0	0	0	0	0	0	230	102	306	346	
Total	**1688**	**815**	**10**	**1723**	2257	**6408**	**3180**	**2784**	**1541**	**3532**	**3572**	**1856**	**2996**	**3159**	

(Source of data: Unraised logsheet data held by SPC; Data covers fleet from Vanuatu, Fiji and Taiwan) The figures for 1992 are incomplete (Source: SPC, Country Report No.15).

Albacore

Although subject to year to year fluctuations, albacore catches in the South Pacific have remained stable since the 1980's at around 30,000 to 40,000 metric tonnes per year. Taiwanese longliners generally account for approximately half of this catch with Japanese and Korean longliners and the New Zealand troll fleet accounting for most of the remainder.

Stocks are generally considered to be in good condition with moderate exploitation levels although recent assessments indicate that fishing mortality may have increased significantly since the mid 1990s.

Yellowfin

Yellowfin tuna are an important component of tuna fisheries throughout the western and central Pacific. The yellowfin resource is harvested with a range of gear types from small scale artisanal fisheries in the Pacific Islands and southeast Asia to large distant water longliners and purse seiners that operate widely in equatorial and tropical waters.

From 1994 to 1999 annual catches of yellowfin in the western and central Pacific Ocean have varied between 398,000 and 457,000 metric tonnes per year. Approximately 54% is taken by purse seiner vessels, catching the surface swimming fish in equatorial waters. Around 16% is taken by longline vessels, targeting the adult fish in deeper waters.

Catch per unit effort for the longline yellowfin fishery is highest in the equatorial zone where most of the catch is taken at between 1-1.5 fish per 100 hooks. In the south, within the 10 to 40 degree South latitude band there has been a recent increase in catch rates from its low level prior to the 1980's to between 0.5-1.0 fish per 100 hooks. Vanuatu, being located within this southern zone, is just south of the prime yellowfin longline area.

Bigeye

Bigeye tuna are an important component of tuna fisheries throughout the Pacific. They are the principal target species of the large distant water longliners from Japan and Korea and of the smaller fresh sashimi longliners based in several Pacific Island countries. Prices paid for both frozen and fresh bigeye on the Japanese sashimi market are the highest of all the tropical tunas.

Since 1980, the Pacific wide catch of bigeye has varied between 88,000 and 163,000 metric tonnes. Japanese longline vessels contribute over 80% of the catch. The catch in the western and central Pacific has fluctuated between 41,000 and 68,000 metric tonnes.

Skipjack

Skipjack are primarily caught by purse seine and pole-and-line gear. Catches in the western and central Pacific have increased steadily over the past two decades, more than doubling since 1980 with a peak catch of 1.1 million metric tonnes in 1998. In the 1990s, catches have fluctuated

between 900,000 and 1,100,000 metric tonnes. Skipjack catch increased during the 1980s due to growth in the international purse seine fleet, combined with increased catches by domestic fleets from the Philippines and Indonesia.

11.2.3 Stocks Status

The status of tuna stocks in Vanuatu is unknown. Grandperrin (1977) indicated that the larger subsurface tuna resource in the Pacific has decreased in size as fishing effort has increased. However, the skipjack resource could be quite substantial and therefore worth considering as a development prospect. Good concentrations of skipjack were observed by the SPC Skipjack Survey and Assessment Programme during its tagging operations in 1977-1978 (Kearney *et al* 1978).

Even though high estimate of potential commercial catch, 5.5 tonnes per day were obtained within Vanuatu waters the data was very limited in that fishing was only carried out for 6 days and thus could not be used to extrapolate to an annual expectation. In addition the operation was carried out during mid-summer, a period of possible abundance above average (Skipjack Programme, 1983). However, the researchers were confident that even with a ten-fold increase in the skipjack fishery in Vanuatu, "there should be no immediate concern that recruitment would be significantly impaired as a result of this increase". The results of the aerial survey conducted by ORSTOM indicated a small overall quantity of tuna sighted. This was considered as a feature of the method and its limitations rather than an indication of tuna abundance. The ORSTOM scientists estimated the potential surface tuna catches, from aerial surveys results, at around several tens of thousands of tonnes (Petit and Henin, 1982).

The SPC survey indicated that significant increases in fishing activities, especially purse-seining, in neighbouring countries may have a serious detrimental effect of the resources available within the Republic's EEZ. That is, sustainability of the status of tuna stocks in Vanuatu waters is determined by the overall exploitation tuna and tuna like species within the Central and Western Pacific Ocean. A lot of scientific studies have been carried out to determine the overall western and central Pacific Ocean tuna stocks, the recents stock assessments were carried out in 2003 and 2004 providing the following summarized results:

Bigeye tuna

Since about 1994, a rapid increase in purse seine catches of juvenile bigeye has created increased uncertainty regarding the sustainability of the current levels of exploitation. Bigeye is the least well understood of the four principal tuna species in the Pacific and there are serious deficiencies in understanding of basic biological parameters for the stock. Consequently the assessment of bigeye is quite uncertain and it is not possible to confidently estimate the current status of the stock.

Recent assessments carried out in 2003 and 2004 indicates that over fishing of the western and central Pacific Ocean bigeye tuna stock was occurring, i.e. F(current/F(msy)>1. The assessments further indicated that current level of fishing mortality F(current) carry high risks of over fishing, with a 67% probability of this occurring.

Yellowfin tuna

Recent assessments carried out in 2003 and 2004 indicates that the yellowfin stock in the WCPO is probably not being overfished, [probability (F(current)/F(msy) > 1; ranged from 15 – 40%]. The studies emphasized that stock is not in over-fished state. However, the 2004 assessments estimated the stock is likely to be nearing exploitation and any further increase in F(current) would move the yellowfin stock to an overfished state.

Skipjack tuna

Stocks are generally considered to be in good condition with moderate exploitation levels although recent assessments indicate that fishing mortality may have increased significantly since the early 1990s. However, recent assessments carried out in 2003 by OFP indicated that the WCPO stock is not being overfished. High levels of recruitment into the fishery were observed.

South Pacific Albacore

Assessments carried out in 2002 and 2003 by OFP estimated low impact of fishing on total biomass. However, the impact of fishing on longline exploitable biomass (i.e. the largest albacore) has now reached 30% (i.e. the current longline exploitable biomass is 30% less than it would be in the absence of fishing. The overall stock is unlikely to be over fished. Observed declines in CPUE in some Pacific island fisheries (including Vanuatu) in recent years may be as a consequence of changed oceanographic conditions and observed high levels of localized fishing effort impacting on the CPUE.

11.2.4 Management

Due to the migratory nature of the tuna species, management of the resource requires a regional approach. These can be in the form of prohibition of certain fishing techniques employed, e.g. no drift gill-netting, and limiting the numbers of fishing vessels. However, the level of exploitation, especially that of skipjack, at present seems to be sustainable. The only kind of control currently operating in the region is geared towards maximising benefits to member countries from the utilisation of the tuna resources by distant fishing nations fishing in the EEZ's through bi-lateral and multi-lateral agreements. However the SPC Tuna and Billfish Assessment Programme is geared towards obtaining sufficient biological information to base management on for the South Pacific tuna fisheries.

The harvest of tuna resources in Vanuatu waters is currently managed by a National Tuna management Plan, developed in 2000 and approved by the Council of Ministers for implementation in 2004.

The Tuna Management Plan has been developed to meet four key objectives:

- To ensure that the exploitation of the tuna resources that are found in and pass through Vanuatu waters is compatible with the sustainability of the stocks throughout their range.
- Within the limits of the sustainability objective, to ensure the harvest is taken in a way that maximizes the long term economic and social benefits received by the peoples of Vanuatu.
- To contribute to the food security of ni Vanuatu.
- To meet regional and international responsibilities for tuna management.

The scope of the Management Plan covers all highly migratory tuna species including: Albacore tuna, Yellowfin tuna, Bigeye tuna, Skipjack tuna and all other species taken in the course of fishing tuna. The Plan covers all Vanuatu waters including the consideration of the area of the Vanuatu EEZ around Matthew and Hunter Islands and Vanuatu flagged tuna fishing vessels wherever they fish. Detailed below are the changes made by the management Plan.

Foreign tuna fishing vessels

Past Situation	Changes
▪ A fleet of mostly Taiwanese vessels fishes in the Vanuatu EEZ - they rarely come close to land ▪ 36 Foreign vessels are currently licensed to fish ▪ They pay $5,000 per vessel per year to fish ▪ They must fish outside of the Territorial Sea - a 12 mile zone around the archipelago	▪ A limit will be set on the maximum number of licenses for Foreign vessels ▪ License fees will be increased from $5,000 to $11,000 per vessel per year for most tuna longliners ▪ Must fish outside of a 24 mile zone ▪ No fishing on sea mounts by foreign vessels ▪ Must carry satellite locators ▪ Observers will be placed on some

	vessels ▪ By-catch will be monitored ▪ Increased enforcement activities

Vanuatu flagged Foreign tuna fishing vessels

Past Situation	Changes
▪ For a fee, foreign vessels are allowed to fly the Vanuatu flag ▪ 85 Vanuatu flagged fishing vessels operate around the world - may be many more soon ▪ Currently little is known about their operations ▪ If these vessels violate international agreements it can result in embargoes and retaliation by other countries against Vanuatu ▪ This could damage future fish exports from Vanuatu	▪ Vanuatu flagged tuna fishing vessels will be required to pay a fee, initially set at $5,000, to cover management costs ▪ Vanuatu will participate in relevant international conventions and commissions ▪ Vanuatu government will be involved in access agreements with foreign countries ▪ Vessels will be required to provide information on their activities or face penalties

Local tuna fishing vessels

Past Situation	Changes
▪ Vessels less than 10 meters are not required to be licensed ▪ Charter game fishing vessels sell their catch without regulation ▪ Duty exemptions are provided to commercial fishermen with and without licenses but not game fishing vessels ▪ Authority within 6 mile provincial zone unclear	▪ Only licensed vessels will be eligible for duty exemptions on fuel and fishing equipment ▪ Vessels 8 meters or more will be required to be licensed, smaller vessels may license to obtain exemptions ▪ Charter game fishing vessels that sell their catch will require a commercial license and then be eligible for duty exemptions ▪ License fee will be 20,000 VT plus 5,000VT per meter over 8 meters ▪ "Local" vessels must be locally owned ▪ Fisheries Division will be the final authority for tuna conservation and management within 6 mile zone ▪ Local vessels larger than 20 meters may be required to: ❑ Carry an observer ❑ Have a satellite locator (ALC) on board ❑ File Telex Reports for entry and exit to EEZ and weekly catches ▪ Local vessels larger than 20 meters will not be allowed within the 12 mile zone or on sea mounts

Coordination and management

Past Situation	Changes

▪ Resources for managing tuna fisheries are limited ▪ No forum for strategic planning ▪ Limited operational coordination between the different agencies involved including: Fisheries Division, Vanuatu Maritime Authority, Police Maritime Wing	▪ A Fisheries Management Account external to general government revenues that will collect a portion of foreign and local license revenues ▪ Fisheries Management Account will finance: ❑ Observers on foreign vessels, ❑ Local development activities, ❑ Better management of foreign fishery. ▪ Permanent Tuna Management Advisory Committee to coordinate and plan. ▪ Tuna Management Coordinator position

Local tuna fishery development

Past Situation	Changes
▪ Small scale tuna fishing mainly being carried out by charter game fishing vessels and small vessels trolling around the Fish Aggregating Device (FAD) ▪ Only one FAD currently in operation and placement and maintenance are by donation ▪ Currently no export of tuna although there is interest and has been in the past	▪ Monies from the Fishery Management Account will be used to place and maintain FADs around Vanuatu to encourage small scale fishing and local sale of tuna ▪ Plan will promote necessary health and sanitary regulations to facilitate future tuna exports ▪ Promotion of foreign investment in local tuna fishery

Limits on License Numbers

The National Tuna Management Plan determines the maximum number of licenses that can be issued in each fishing category with *tuna* or *tuna like species* as a target species. The table below outlines the fishing category and license limit.

Fishing Category	Vessel/license limit
A. Tuna longline	100
B. Tuna purse seine	10
C. Tuna pole-and-line	10
D. Other	100
E. Research fishing	No Limit
F. Exploratory and test fishing	2

Total Allowable Catch

The importance of sustainable management of the tuna resources within the Vanuatu EEZ, meant that the Management Plan has to set out total allowable catches (TACs) for the major tuna species. Total TAC for Vanuatu waters is 17,000 metric tonnes. The total TAC comprises Albacore, Yellowfin, Bigeye and Skipjack tuna. The Table below outlines the TACs for the four major tuna species.

TACs for major tuna species

Species	Total allowable catch/year
Albacore	10,000 Metric tonnes
Yellowfin	3,000 Metric tonnes
Bigeye	1,000 Metric tonnes
Skipjack	3,000 Metric tonnes

Fees

The management plan also details the amount of fees for the different fishing categories, as can be seen on the table below. All Fees are in US dollars unless specifically indicated.

Foreign vessel fees

Fishing Category	GRT	Foreign	Locally based foreign
A. Tuna Long Line	<100	$9,000	$4,500
	>=100	$11,000	$5,500
B. Purse Seine	-	$25,000	$12,500
C. Pole and line	-	$3,000	$1,500
D. Other methods		$3,000	Based on length see Schedule
E. Research Fishing		$500	$500
F. Exploratory and Test Fishing		Standard rate for method, prorated for shorter period if appropriate	Standard rate for method, prorated for shorter period if appropriate

Fees for Locally Based Foreign vessels fishing using "D, Other Methods"

Vessel Category	License Fee
<= 8 Meters	40,000 VT
> 8 Meters	40,000 VT + 10,000 VT per meter over 8 meters

Fees for local vessels (all fishing methods)

Vessel Category	License Fee
<= 8 Meters	20,000 VT
> 8 Meters	20,000 VT + 5,000 VT per meter over 8 meters

Fees for authorizations for Vanuatu flagged vessels to fish under regional agreements

Regional Agreement	Authorization Fee
IATTC	$5,000
MHLC	$5,000
CCSBT	$5,000
IOTC	$5,000
ICCAT	$5,000

Fees for Reefer/Carriers

Item	Fee
Reefer/Carrier License (valid 12 months)	$700

Transhipment fee: Sashimi grade tuna	$12.50 per Metric Tonne
Transhipment fee: Cannery grade tuna	$2.00 per Metric Tonne

11.2.4.1 Current legislation/policy regarding exploitation:

The Department of Fisheries is responsible for the management of the Republic's tuna resource under the Fisheries Act 1983. Following the endorsement of the National Tuna Management Plan by the Government, the development and management of tuna resources in Vanuatu waters is based on the Tuna Management Plan

11.2.4.2 Recommended legislation/policy regarding exploitation:

The newly drafted Fisheries Act must be passed by Parliament as soon as possible. The enactment of the new Fisheries Bill will further strengthen the development of the domestic tuna industry.

Inorder for Vanuatu to obtain greater benefits for its tuna resources it is highly essential that the Government facilitates the development of a shore base facility whereby foreign fishing vessels operating in Vanuatu waters can be subjected to off load their catch for re-export overseas.

11.3 BILLFISH

11.3.1 The Resource

Species present:
Black marlin (*Makaira indica*), Blue marlin (*Makaira mazara*), Striped marlin (*Tetrapturus audax*), Broadbill swordfish (*Xiphias gladius*), and Sailfish (*Istiophorus platypterus*)

11.3.1.1 Distribution

Geographical distributions of the billfish species are given in Nakamura (1985). Generally, they are primarily oceanic, epipelagic inhabiting tropical and temperate waters, and seasonally, also the cold waters of all oceans. They are usually confined to the water layers above the thermocline but some may occur at greater depths.

***Makaira indica* (Black Marlin)**
Black marlins are distributed throughout the tropical and subtropical Indian and Pacific Oceans. Like the sailfish, Black marlins are more closely associated with land masses than either the blue or strip marlin.

Tagging studies indicated a single black marlin stock, which migrate between the eastern and southwest Pacific during El Niño years. Black marlins are highly mobile. Major seasonal concentrations occur in the morthwest Coral Sea (September – December), the northeast Indian Ocean (November- March), the eastern Banda Sea west of Irian Jaya (January-April), and the East China Sea between Taiwan and Japan (June-November). There are strong indications that the distribution and movements of male and female black marlin may differ.

Makaira indica (Blue marlin)
Blue marlin are the most tropical of all marlins but are distributed throughout the tropical and subtropical regions of the Indian and Pacific Oceans. A single stock is assumed for each ocean. Like the Striped marlin, they rarely encountered in shallow nearshore waters, preferring blue, oceanic waters.

Blue marlins occur in equatorial waters year-round but part of the stock makes seasonal migrations to the north and south during the respective summer seasons in each hemisphere. It is believed that these summer migrations are primarily by “shoals” of mature males between 35 kg and 75 kg and that year-to-year bariability in catch-rates of blue marlin away from the equator are strongly influenced by the numbers of males migrating. Good catch-rates occur when large numbers of males migrate.

Tetrapturus audax (Striped marlin)
Striped marlins are found in tropical, subtropical and temperate waters of the Indian and Pacific Ocenas. In common with blue marlin, they are true oceanic species rarely found in shallow coastal waters.

Xiphias gladius (Broadbill swordfish)
Broadbill swordfish are found in tropical, temperate and sometimes cold waters of all oceans. They are restricted to blue, oceanic water. They are rarely found in waters less than 20 meters in depth.

Istiophorus platypterus (Sailfish)
Sailfish have a tropical distribution which extends into subtropical waters of the Indian and Pacific Oceans. In the Western Pacific they occur between 27ºS and 40ºN and in the east between 5ºS-25ºN. Peak concentrations in the Pacific occur around Papua New Guinea, Irian Jaya, the Caroline Islands, Solomons Islands and the East China Sea.

Distribution of Billfish in Vanuatu is likely to be highly seasonal. Although occasional black marlin may be caught, most fish are blue or striped marlin. Blue marlins are present in significant numbers from November through March. They may be more abundant from Espiritu Santo north than further south. Striped marlins are likely to be caught around the southern half of Vanuatu from September to December, with a distinct peak in October and November. Because Vanuatu is towards the southern limit of the normal range of blue marlin and towards the northern end of the range of blue marlin and towards the northern end of the range of striped marlin, high year-to-year variability in the relative numbers of the two species might be expected as oceanic conditions very.

Good years for one species are likely to be poor years for the other, as in Hawaii, and may relate to the southward extent of the South Equatorial Counter Current. Years with warmer water temperatures may see higher catch-rates of blue marlin while years with cooler temperatures may see higher catch-rates of the striped marlin.

11.3.1.2 Biology and ecology

***Makaira indica* (Black Marlin)**
Females grow in excess of 700 kg, whereas males rarely exceed 200 kg. Available information on age indicates that female black marlins may reach 15 kg in their first year, and 30 kg in their second. A 450 kg female is over 10 years old. Males probably reach similar ages as females, but with slower growth rates.

Like all the other fishes in the family *Istiophoridae*, the Black Marlin is a very fast swimmer. Its food consists largely of other large fast swimming fishes such as tunas, mackerels, trevallies, and swordfish. Less important foods include other fishes, squids, and large crustaceans. Analysis of stomach contents indicate that the Black Marlin uses its bill to slash prey before it is swallowed

***Makaira indica* (Blue marlin)**
Blue marlins are sexually dimorphic in size with females reaching 900 kg while males may weigh up to 170 kg. Males reach maturity at 30–40 kg and females between 47-80 kg, although substantially larger females may not have reached sexual maturity. Males live to 21 years and females to at least 28 years. Blue marlins grow rapidly over 3-4 years to 80 kg, and with the onset of sexual maturity, male growth rates decrease, whereas females continue with rapid growth.

Spawning is believed to occur year-round in equatorial waters but is limited to summer months at higher latitiudes. Peak activity may be centered about the eastern Caroline and the Marshall Islands (Micronesia) in the western Pacific and French Polynesia in the east.

***Tetrapturus audax* (Striped marlin)**
Striped marlin mature at 27-40 kg, and while there appears to be little sexual dimorphiem in size, in the easten Pacific the percentage of females tends to increase with the size of the fish. Striped marlins grow to a maximum of 260 kg in at least 10 years.

***Xiphias gladius* (Broadbill swordfish)**
Age and growth rates of broadbill swordfish are poorly understood, particularly in the Pacific and Indian Oceans. After about 2 years of age, females grow faster than males, reach a larger maximum size (about 540 kg) and may live longer than males. Males mature at 2-3 years (about 20 kg) and females at 4-5 years (around 75 kg).

***Istiophorus platypterus* (Sailfish)**
Sailfish spend considerable time in nearshore coastal waters, presumably to take advantage of the seasonal abundance of baitfish schools. There are no external features to distinguish the sexes and while it is generally believed that males and females reach equivalent weights, the larger fish are usually female. Sailfish grow to 100 kg with an average size if between 25 and 40 kg. Males are not mature until they reach at least 20-25 kg and females closer to 30-35 kg.

No study has been conducted for these species within Vanuatu waters, however, Smith (1992) notes that all of the bill fishes are predators mostly on fish and squid. Some biological information for the billfishes is given in Nakamura (1985). Sexes are separate and that they are active and voracious predators but are occasionally preyed on by large oceanic fishes such as tunas, wahoo, dolphinfishes and skipjacks particularly during their younger stages. The young are sometimes also taken by adult billfishes. Smith (1992) also notes that billfishes are solitary while other species tend to form small to medium sized schools. Migrations associated with spawning are known for billfish and dolphinfish.

11.3.2 The Fishery

11.3.2.1 Utilization

The survey of village subsistence fishing conducted in Vanuatu in 1983 indicated the production of deep-sea fish but no records were made on offshore pelagic in home consumption. It is assumed then that these species did not form any important component of the subsistence fish consumption. However, recent developments of the village fishing programme for off-shore fishing has led to the utilization of these resources on all levels, i.e. village, artisanal and commercial. The majority of the catch is sold to customers at the landing sites, fish markets in Vila and Luganville or directly to restaurants (include hotel restaurants).

The pelagic resources support the sport fishing industry in Vanuatu. Large quantities of the species are caught by game fishers which are also sold at the local markets for domestic consumption. Large catches are made by small fishing enterprises around FADs.

Fishing within Vanuatu's EEZ between 1962 and 1977 by the Japanese and Taiwanese longliners and between 2003 and 2004 by locally based foreign fishing vessels also caught several species of marlin, in addition to sailfish and broadbill swordfish.

11.3.2.2 Production and marketing

Details of catches by the Japanese (1962 to 1977) and Taiwanese (1967 to 1977) longliners operating within Vanuatu waters between 1962 and 1977 is given in Skipjack Programme (1981) and is summarised for the period 1967 to 1977 in Table 41 below. Catch figures are in numbers of fish and effort in thousands of hooks.

Table 41. Detail catch of billfish in Vanuatu waters by Japanese & Taiwanese vessels 1967-1977

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Japan											
B/bill	564	104	1	12	47	54	11	3	0	0	0
Str/mar	163	178	2	98	324	223	34	0	0	0	0
Blu/mar	170	99	1	50	217	46	37	23	2	1	1
Bla/mar	33	10	0	5	23	10	16	6	0	1	0

Sailfish	202	18	2	40	171	126	84	41	0	7	0
Total	**1,132**	**409**	**6**	**205**	**782**	**459**	**182**	**73**	**2**	**9**	**1**
Effort	1,104	475	2	33	143	188	102	14	5	2	1
C/effort	1.03	0.86	3.0	6.21	5.47	2.44	1.78	5.21	0.40	4.50	1.00
Taiwan											
B/bill	22	44	73	52	70	102	128	50	39	70	85
Str/mar	75	33	20	129	104	313	287	16	30	91	352
Blu/mar	248	329	240	585	610	486	633	338	171	882	358
Bla/mar	9	24	19	50	43	89	60	17	17	30	24
Sailfish	0	28	57	81	18	55	109	42	50	538	166
Total	**354**	**458**	**409**	**897**	**845**	**1,045**	**1,217**	**463**	**307**	**1,611**	**985**
Effort	546	493	417	667	1,152	1,271	2,216	772	749	1,305	1,332
C/effort	0.65	0.93	0.98	1.35	0.73	0.82	0.55	0.60	0.41	1.23	0.74

Note: These figures only constitute the non-tuna portions of the catches using the effort recorded. The rest of the catch (the major portions) are recorded under the Profiles for Tunas.

During the OFCF fishing trials in southern and eastern coastal areas and around FADs off Santo Island during the 1985-86 period the following data were recorded (figures in kg):

Table 42. Billfish catch for years 1985 - 1986

Species	**1985**	**1986**
Marlins	**38.5**	**670.6**

Billfish data collected by the Department of Fisheries from 1987 to 2003 is incomplete due to the fact that Game fishing vessels that normally target this resource were not forth coming with provision of their catch data. Artisanal fishing projects target mainly the deepwater bottom and and catch billfish as by-catch. The quantity of billfish caught by small-scale rural fishing projects is very small that it is often not reported. In 2000, the Department of Fisheries recorded a total weight of 324 kg of Marlin caught by artisanal fishing projects located on Efate island. Summarized below are production sales of billfish by Sanma Fish Market.

Table 42 (b). Billfish sales by Sanma Fish Market

	2001		**2002**	
Species	**KG**	**VT**	**KG**	**VT**
Blue Marlin	1,063	300,515	-	-
Sword fish	412	123,600	302	90,600

Most accurate billfish data are those provided by foreign fishing vessels licensed to fish in Vanuatu waters. Summarized below are catch data submitted by Vanuatu licensed foreign fishing vessels for 2001:

Table 43. Billfish catch by Vanuatu licensed foreign fishing vessels (2001)

Species	**Quantity (kg)**
Striped Marlin	4,401
Blue Marlin	7,001
Black Marlin	906
Swordfish	3,048
Sailfish	265
TOTAL	**15,621**

More detailed catch data can be obtained from the Secretariat of the Pacific Community Tuna Fishery Year Book for 1999 – 2003.

11.3.3 Stocks Status

No assessment work on the oceanic pelagic species has been conducted in Vanuatu. In the past no fishery specifically targets these except they tend to be "by-catches" of the troll fishing for the tunas and local market demand for these species was very limited except for dolphin fish which had a high value close to that of poulet (deep bottom snapper).

However in the recent past the demand for the oceanic pelagic species by the local markets has increased. This demand is fueled the steady increase in the urban population. There is no indication of over-exploitation of these resources.

An ACIAR study, conducted by AIMS, looked at the development of gamefishing tourism, with emphasis on billfish, in PNG, Solomon Islands and Vanuatu. Based on Japanese longline catch data between 1962 and 1970 the results indicated that fishing for billfish is likely to be very highly seasonal in Vanuatu. However, blue marlin is expected to be in significant numbers from November through March (Williams, undated-draft document).

11.3.4 Management

11.3.4.1 Current legislation/policy regarding exploitation:

There is no national specific legislation that deals with the harvesting of these resources. However, since they, especially the marlins, form a good portion of the catches by longliners, their utilization would fall under bi-lateral agreements for DWFN to fish in Vanuatu's EEZ.

11.3.4.2 Recommended legislation/policy regarding exploitation:

None seems necessary at present. However, given the flourishing gamefishing industry in Vanuatu, a system of collecting catch data from this development urgently needs to be formulated and administered by the Fisheries Department.

12 OTHER OCEANIC PELAGIC FISHES

12.1 The Resource

Species present:
Dolphin fish (*Coryphaena hippurus*), rainbow runner (*Elegatis bipinnulatus*), wahoo (*Acanthocybium solandri*), and barracudas (*Sphyraena* spp).

12.1.1 Distribution

These species are normally distributed throughout the oceans in varying abundance determined mostly by food availability and are normally associated with FADs and in coastal deep waters of Vanuatu and formed a good portion of the by-catches from various specific fishing methods targeting big tunas.

12.1.2 Biology and ecology

No study has been conducted for these species within Vanuatu waters. Smith (1992) notes that all of these are predators mostly on fish and squid. Sexes are separate and that they are active and voracious predators but are occasionally preyed on by large oceanic fishes particularly during their younger stages. Migrations associated with spawning are known for dolphinfish.

12.1.3 The Fishery

12.1.3.1 Utilization

The survey of village subsistence fishing conducted in Vanuatu in 1983 indicated the production of deep-sea fish but no records were made on offshore pelagic in home consumption. It is assumed then that these species did not form any important component of the subsistence fish consumption. However, recent developments of the village fishing programme for off-shore fishing has led to the utilization of these resources on all levels, i.e. village, artisanal and commercial. The majority of the catch is sold to customers at the landing sites, fish markets in Vila and Luganville or directly to restaurants (include hotel restaurants).

The pelagic resources support the sport fishing industry in Vanuatu. Large quantities of the species are caught by game fishers, which are also sold at the local markets for domestic consumption. Large catches are made by small fishing enterprises around FADs.

12.1.3.2 Production and marketing

Crossland (1984) reported the following purchases (in kgs) of two oceanic pelagic species by both former Natai and Santofish markets for a one year period between 1983 and 1984:

Table 44. Purchases by former Natai and Santofish Markets

	Wahoo	**Mahimahi**
Natai (May 1983-July 1984)	2,011	1,918
Santofish (July 1983-July 1984)	325	743

Those sold to the once operated island Fisheries Extensions, the Natai Fish Market and Santofish between the periods 1988 to 1992 are listed in table 45 below: (Source: Fisheries Department and Santofish Databases). The values of the pelagic fishes were only available from the former Natai Fish Market sales record.

Table 45. Pelagic fish purchases by Natai, Santo Fish, and Fisheries Centers

	Natai (kg)	Value (Vatu)	F/Ext (kg)	Santofish (kg)	Total (kg)
1988					
M/mahi	240.2	45,413			240.2
Wahoo					
R/runner	173.8	26,442			173.8
1989					
M/mahi	155.0	31,117		61.5	216.5
Wahoo				263.1	263.1
R/runner	41.0	5,690		37.6	78.6
1990					
M/mahi	103.4	22,616	988.3	131.3	1,223.0
Wahoo				173.1	173.1
R/runner	42.7	6,534		139.4	182.1
1991					
M/mahi	102.4	30,278	73.0	106.9	282.3
Wahoo				527.2	527.2
R/runner	4.6	831		32.5	37.1
1992					
M/mahi	774.2	169,150	3,412.1	548.8	4,735.1
Wahoo				147.0	147.0
R/runner	20.7	3,933		19.3	40.0

During the OFCF fishing trials in southern and eastern coastal areas and around FADs off Santo Island during the 1985-86 period the following data were recorded (figures in kg):

Table 46. Pelagic fish catch by OFCF fishing trials

Species	**1985**	**1986**
Dolphin-fish	1,374.7	642.9
Rainbow runner	146.5	149.2
Other	13.0	30.5
TOTAL	**1,534**	**823**

Fisheries Department data for pelagic fish catch by artisanal fishing projects is not complete due to very poor data submission by fishing projects. One of the reasons for poor data submission is due to the fact that artisanal fishing projects do not target pelagic fish. Pelagics are caught as by-catch are often not recorded and submitted to Fisheries Department.

However, there are some artisanal fishing projects that target the pelagic fish. The fish are sold directly to restaurants and hotels. These fishing projects are on Efate island and have access to FAD deployed 7 miles off Devils point. Even data collection from these fishing projects is very poor. Summarized below are pelagics caught and sold at the Port Vila Urban Markets.

Table 47. Catch data for 2000, 2002 and 2003

	2000		2002		2003	
Species	**KG**	**VT**	**KG**	**VT**	**KG**	**VT**
Mahimahi	258	64484	6	2200	350	139,019
Rainbow runner	273	78200	5	1100	6.1	1590
Wahoo	1347.9	436718	92	36300	4683	923940
Barracuda	-	-	-	-	34	12700

The above figures is not representative of the overall total pelagic fish production by small fishing projects for Vanuatu. The data is not complete. The local fish markets have not cooperated in submitting their production figures.

12.1.4 Stocks Status

No assessment work on the oceanic pelagic species has been conducted in Vanuatu. In the past no fishery specifically targets these except they tend to be "by-catches" of the troll fishing for the tunas and local market demand for these species was very limited except for dolphin fish which had a high value close to that of poulet (deep bottom snapper).

However in the recent past the demand for the oceanic pelagic species by the local markets has increased. This demand is fueled by the steady increase in the urban population. There is no indication of over-exploitation of these resources.

12.1.5 Management

12.1.5.1 Current legislation/policy regarding exploitation

There is no national specific legislation that deals with the harvesting of these pelagic fish resources. However, the Fisheries Act empowers the Director of Fisheries to draw up management plans to control exploitation levels of the resource.

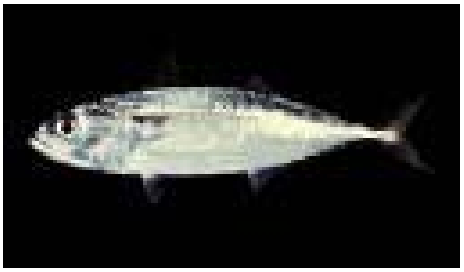
12.1.5.2 Recommended legislation/policy regarding exploitation

The Department of Fisheries needs to improve its data collection procedures to ensure that sufficient data can be collected. The following recommendations should be considered:

- Given the flourishing gamefishing industry in Vanuatu, a system of collecting catch data from this development urgently needs to be administered by the Fisheries Department,
- The Department of Fisheries urgently needs to improve its statistics division and provide appropriate trainings for its Statistician
- All artisanal fishing projects must pay a fishing license fee,
- Fish market outlets must be obligated by way of a policy to provided data

12.2 BAIT-FISH (SMALL PELAGICS)

12.2.1 The Resource



Species present:
The SPC 1977 and 1978 skipjack and baitfish resources assessment in Vanuatu waters identified sixty bait-fish species caught in bouki-ami hauls. The dominant species include: *Spratelloides delicatulus*, *Stolephorus indicus*, *S. devisi, Hypoatherina ovalaua*, *Herklotsichthys punctatus* (*quadrimaculatus*), *Apogon (Rhabdamia) cypselurus, Pterocaesio pisang,* and *Pterocaesio* sp. Other common species include; *Benthosoma fibulatum, P. diagramma, Selar crumenphthalmus, Decapterus macrosoma, Priacanthus* sp., *Xiphasia setifer*, and *Archamia lineolata*. The only information found (available) on the 1982 joint survey of the bait-fish resource by the Fisheries Department and SPFC is a diary of activities (Blackburn, 1982). The dominant species caught by stick-held dip nets fishing using fish gathering lamp at night, as conducted by OFCF in 1985, reported bait-fish catches of the following species: *Herengula ovalis*, *Sardinops melanosticta*, *Allanetta*, *Spratelluides delicaturus*, *Thachurops cruenophthalmus*), *Siphamia versicolor*, *Engraulidae*, *Dussunieria hasselti*, *Grammatorcynus*, *Elagatis bipinnulata*, *Decapterus muroadsi*, *Rastrelliger kanagurta* and others (Anon, 1987).

12.2.1.1 Distribution

Dalzell (1993) gave some available details of the distribution of the small pelagics in the South Pacific as follows. The smaller gracile stolephorid anchovies, particularly *E. heteroloba* and *E. devisi* and the sprats, *S. gracilis* and *S. delicatulus* (and *S. lewisi* in the waters of PNG and Solomon Islands) are found in the coastal lagoons of the coralline areas. The larger anchovies, including *Thryssa balaema*, *T. setirostris* and the larger stolephorids such as *S. indicus* and *S. waitei,* are often found in lagoons and passages that are bordered by mangroves. The fusiliers (*Caesio* and related genera) distribution is determined largely by the extent of coral cover which is associated with shallow coastal water (<30 m depth). The mackerels (*Rastrelliger* spp) occur further offshore whereas the roundscads (*Decapterus* spp) are found between the neritic and oceanic areas with flying fishes inhabiting both inshore waters and open-ocean (Dalzell and Lewis. 1989).

In 1984, several bays in Vanuatu were surveyed using purse seine, dip net and trap nets yielding very poor results. This survey concluded that areas of high baitfish concentrations could be absent in Vanuatu due to the lack of suitable wide coastal shelf that is characteristic of good baitfish environment (Habib, 1984).

Using admiralty charts, the SPC Assessment survey in 1977 identified only three islands that seemed to have suitable sites for baitfishing using bouki-ami. These were Espiritu Santo, Malekula and Efate. Only five hauls were set in three different sites in only two islands, Turtle Bay (Santo), Port Stanley (Malekula), and Port Sandwich (Malekula) (Tuna Programme, 1983). (Note: The use of the bouki-ami for baitfishing requires that water depth is suitable and the area protected from excessive wind, current and wave action).

Surveys using beach-seines and lampara net were conducted in 1982. Results from both methods yielded results that compared favourably with those of the Skipjack Programme from other parts of the Pacific (Habib, 1984).

The OFCF/Fisheries Department survey in 1982 concentrated in the Santo area within the southern and eastern coast. Because of the presence of many "curves and indentations and numerous inlets and coves", the area was thought to have good fishing grounds for bait-fish. Bait-fishing trials were carried out in twelve locations within these coasts using the stick-held dip net technique. The 12 locations were Port Olry, Hog Harbour, Shark bay, Turtle Bay, Aise Island, Souranda Bay, Palekula Bay, Aore Island, Luganville Anchorage, Tangoa Point, Tasmalne Point

and Tasiriki Bay. Schools of *H. ovalis* and *S. delicatulus* were often observed under the wharves within the Luganville anchorage and Palekula Bay where night baitfishing was prohibited. Adult baitfishes of these two species were only observed for short periods of time (Anon, 1987).

The SPFC/Fisheries Department baitfish survey of 1982 also conducted surveys within the Palekula Bay, Hog Harbour, Port Olry, Shark Bay, Turtle Bay, Aore and Malo Islands, Tangoa and Tangice Islands and Tasmalum.

12.2.1.2 Biology and ecology

Most studies on the small pelagic fishes in the Pacific have concentrated on the species that are important to the pole-and-line fishery and which include anchovies, sprats and clupeids. However, "the biology of the small mackerels, flying fishes, scads and halfbeaks has tended to be neglected in the region" (Dalzell, 1993). The only exception here is the study conducted by Conand (1986) on the biology and ecology of the larger small pelagic fishes and the smaller clupeoid species in the lagoon of New Caledonia (quoted in Dalzell, 1993). Based on their life history parameters, Conand (1986), Lewis (1990) and Dalzell (1993) separated the tropical small pelagic fishes into three groups as follows:

Group	Life cycle	Size	Growth	Age sexual maturity	Spawn	Batch fecundity
One (Species: Stolephorid anchovies (*E. heteroloba*, *E. devisis*, *E. punctifer*),Sprats (*S. gracilis*, *S. delicatulus*, *S. lewisi*) and Silverside (*Hypoatherina ovalau*))	1 year	7 - 10 cm max	Rapid	3-4 months	extended period	500-1500 oocytes/grm of fish
Two (Species: Herring and sardines (*Herklotsichthys* spp., *Amblygster* spp., *Sardinella* spp.), Larger anchovies (*Thrissina* spp., *Stolephorus* spp), Sharp nosed sprats (*Dussumieris* spp.))	1 to 2 years	10-24 cm max	-	towards end first year	restricted seasonal	300-500 oocytes/grm of fish
Three (Species: Round scads (*Decapterus* spp), Big eye scads (*Selar* spp), Small mackerels (*Rastrelliger* spp), Flying fish (Exocoetidae), Half beaks (Hemiramphidae)).	2-5 years	20-35 cm max	-	-	restricted seasonal	400-600 oocytes/grm of fish (50-100 for flying fish)

Dalzell (1993) gave a summary table for the growth, mortality and maturity parameters for a number of small pelagic fish species in the South Pacific and is reproduced below:

Table 48. Biological parameters for some small pelagic fish species in the South Pacific.

Species	Location	L_∞ (cm)	K yr^{-1}	M yr^{-1}	t_{max} (year)	L_m (cm)	L_m/L_∞	Ref
Encrasicholina heteroloba	PNG	7.9	2.6	4.9	1.0	5.1	0.65	Dalzell (1984)
Stolephorus Waitei	PNG	10.9	1.7	3.4	1.5	7.3	0.67	Dalzell (1987, 1989)
Spratelloies delicatulus	Fiji	7.3	4.6	6.9	0.4	4.0	0.55	Dalzell *et al* (1987)
Atherinomorus lacunosus	New Cale	11.4	2.5	4.1	1.2	8.5	0.75	Conand (1988)
Herklotsichthys quadrimaculatus	Fiji	12.6	2.0	3.5	1.6	9.5	0.75	Dalzell *et al* (1987)
Amblygaster Sirm	New Cale	22.9	1.5	2.4	2.0	15.0	0.66	Conand (1988)
Decapterus russelli	New Cale	24.9	1.3	2.1	3.0	18.0	0.72	Conand (1988)
Selar crumenophthalmus	Hawaii	27.0	2.57	3.4	2.0	23.0	0.85	Kawamoto (1973)
Rastrelliger kanaurta	New Cale	23.7	3.0	3.7	1.0	20.0	0.87	Conand (1988)

Most of the small pelagics are considered planktivorous except that scads, mackerel and the larger anchovies feed on small fishes.

Although the presence of suitable fishing grounds, e.g. along the eastern and southern coasts of Santo Island, due to the presence of numerous coves, inlets and indentations, the absence of atolls there to act as nursery grounds for bait fish fry seem to have an effect on the abundance available. The general features of the coves and inlets are "either shallow for some distance from the shore with coral sand and reef or rocky" (OCFC, 1987). In addition, the areas, except Palekula Bay, are all liable to be influenced by trade wind and are often turbid.

The OFCF report (1987) noted that during April (1985) when most of the nights were calm and stable, schools of *S. melanosticta*, *H. ovalis*, *Allanetta* and *S. delicaturus* gathered well around the fish aggregating lights at night. However, the unsuitable species for bait, such as *S. melanosticta*, *D. muroadsi*, *Grammatorcynus* and *E. bipinnulata* increased in proportion after mid-May. During poor weather condition in and after June there was a marked decrease in schools aggregating around the lights at night except for very few fry and juvenile fish.

12.2.2 The Fishery

12.2.2.1 Utilization

The OFCF baitfish survey had 76.4% of the total catch consisted mainly of *H. ovalis*, *S. melanosticta*, *Allenetta* and that only *H. ovalis*, *S. melanosticta* and *S. delicatulus* were found to be hardly enough to be kept and used as live bait-fish. Other species were unsuitable due to size and poor survival. During the SPC skipjack and baitfish assessment in Vanuatu, the blue sprat, *S. delicatulus* was the dominant species by numbers and weight. This particular species is regarded as excellent skipjack bait and is easily attracted to lights around which it forms surface aggregations. The second most abundant species was *S. indicus* but due mainly to its large size and it being extremely delicate, it is useless as bait. The hardyhead, *H. ovalaua* and the sardine, *H. punctatus*, also contributed substantially to the catch but only *H. punctatus* is regarded as a good baitfish for skipjack.

Sardines (clupeids) and mackerel *(Rastrelliger* and *Selar* spp.) are caught locally using cast nets, fine mesh gillnets (25 m long) and sometimes jigging (for mackerel) just off the reef using lights and hook-and-line. There is no data available on species composition from the subsistence

fisheries to give an indication of the importance of the small pelagic fishery to the local fish-food consumption. The only available data are some from the former Santofish market on Santo and once operated Fisheries Extensions on the outer islands.

Excess small pelagics, like other marine products, in the outer islands is normally sent to the urban fish markets in Vila and Luganville. Sardines and mackerel are also sold in the supermarkets, e.g. Bon Marche in Vila.

12.2.2.2 Production and marketing

The total bait-fish catch in four hauls during the SPC survey in December 1977 amounted to 124.5 kg for an average of 31.1 kg per haul. An additional haul was made in Port Stanley in January catching 52.5 kg of bait. It was noted that the results were similar to those executed during the JAMARC surveys which, from 9 hauls, yielded an average of 30.7 kg per haul (SPC, 1983). These figures were among the lowest obtained by the Skipjack Programme in the different countries surveyed and were insufficient to support commercial fishing of vessels the size of Hatsutori Maru 1 which normally requires 50 kg per fishing day.

Table 49. Catches by the OFCF fishing trials

Species	**Catch (kg)**
H. ovalis	196
S. melanosticta	104
Allanetta	60
S. delicatulus	17
T. crumenopthalmus	1
S. versicolor	4
Engraulidae	1
D. hasselti	2
Grammatorcynus	10
Elagatis bipinnulata	9
D. muroadsi	41
R. kanagurta	20
Other	6

Baiting in shallower areas was tested in January, February, March and June 1982 by the Fisheries Department. Beach seine was used during the day and lampara net at night. Nine sets of beach seine yielded an average of 29 kg per set and 14 sets of the lampara net gave an average of 39.2 kg. The results compared favourably with those in other countries using these same methods (SPC, 1983). However one of the lampara sets hauled in 364 kg which consisted mainly of the sardine *H. punctatus*, a species which had been shown to undergo significant natural fluctuations in abundance, as noted in Vanuatu, Marshall Islands and Kiribati (SPC, 1983). Excluding the 365 kg haul, the average lampara catch for 13 hauls would be 14.2 kg, a figure much less than the beach seine and bouki-ami catches in Vanuatu.

During the SPFC/Fisheries Department Survey in 1982 the potential bait catches were estimated by Japanese experts to be 2 and 5 tonnes per haul in Hoghabour and Turtle Bay (Santo) respectively (Blackburn, 1982). "However, actual night baitfishing trials in September of that year failed to confirm these estimates, suggesting that the estimates were unduly optimistic and/or were affected by the seasonality of the resource" (Grandperrin et al 1982, quoted in SPC, 1983).

No figures are available for the subsistence or artisanal fisheries. The artisanal fishery for sardines and mackerel are mainly in Santo and Efate. Mackerel in Santo is usually caught using nets and spears.

Yearly data (weights in kg) of small pelagic fish sold to the Fisheries Extensions (1990-1992) on the outer islands are as follows (source Fisheries Department data):

Table 50. Small pelagic purchases by Fisheries Centers

	1990	**1991**	**1992**
S. crumennophthalmus	129.0	210.7	689.3
Clupea sp	1,225.6	192.0	228.5

The summary of inshore pelagics sales at Santofish on Santo between 1989 and 1992 is presented in the following table (weights in kg) (source: Santofish database, Santo):

Table 51. Inshore pelagics sales by SantoFish

	1989	**1990**	**1991**	**1992**
Mackerel	6,583.9	9,882.6	12,257.9	6,649.5
Sardine	1,348.6	216.1	238.5	405.3

In 1992 it was estimated that 1 tonne of reef fish was sold through the Au Bon Marche supermarket in Vila during 1992 of which part included sardines and mackerel.

The only recent production data collected by the Department of Fisheries dates back to 2001, and was submitted by a fish market in Luganville, Santo.

Table 52. Inshore pelagic sales by Sanma Fish Market

	2001		**2002**		**2003**	
Species	**KG**	**VT**	**KG**	**VT**	**KG**	**VT**
Mangru	206.5	49,390	1788	369,090	415.5	41375
Sardine	24.5	2940	-	-	38	8600

12.2.3 Stocks Status

No study has been done to assess the stocks of small pelagic fishes in Vanuatu and there is currently no baitfishing for pole-and-line tuna fishing. The high catch of the sardine, *H. punctatus*, in one of the lampara hauls does not reflect its abundance. This particular species, even though a good baitfish for skipjack, is vulnerable to exploitation.

The SPC assessment in 1983 concluded that:

> "examination of coastal charts for Vanuatu suggested that there were few suitable, large baitfishing areas and that total baitfish resource would thus be limited. The SPC survey confirmed this limitation of the baitfish resources vulnerable to exploitation by the bouki-ami technique. Surveys in other areas have shown that species, which are available exhibit wide seasonal fluctuations in abundance. The absence in Vanuatu of large quantities of species such as *S. heterolobus*, *S. devisi* or *S. gracilis*, which constitute the bulk of baitfish catches in PNG and Solomon Islands, certainly detracts from the stability of the baitfish resource."
>
> "the results of day-baiting potential showed some reasonable daily catches but constituted mainly of species which are likely to show marked variability in abundance and rapid decline in abundance in response to fishing pressure. It is therefore concluded that even though some sizeable catches are possible on a seasonal basis, the baitfish resources of Vanuatu are inadequate to support a commercial pole-and-line fleet year-round."

There are indications that some species caught locally in the subsistence and artisanal fisheries as inshore pelagics include those that form the baitfish fishery for pole-and-line. Subsistence and artisanal levels of exploitation of the small pelagic fishes in Vanuatu, as it is in other South Pacific states, seems to be on a sustainable level. As Dalzell (1993) noted "most reports on possible overfishing of small pelagic stocks are anecdotal without any supportive quantifiable evidence".

Studies in the Solomon Islands have indicated that the occurrence of reef fish juveniles (non-target species) in the commercial bait catches could have a detrimental effect on the subsistence fishery in commercial baitfishing areas (Rawlinson, 1989). However fish caught in the subsistence-artisanal fishery do not eat baitfish except for some pelagic species, mainly Scombridae, which are caught by trolling (Blaber *et al*, 1989 and 1990).

12.2.4 Management

The SPC surveys suggest that supply of live bait-fish may present problems for the commercial operation of a pole-and-line tuna fishery within Vanuatu. Thus the stocks would not be able to sustain and support any commercial harvesting of tuna. In addition the species show seasonality in occurrence. Because of the lack of information on the species caught locally in the subsistence and artisanal fisheries management strategies would be difficult to devise. This is particularly so with the species which have short lifespans and high mortality rates where high fishing might be advantageous as many will die before completing much of their growth (Dalzell, 1993).

However, constant heavy fishing pressure would eventually, in addition to the effects of environmental factors, lead to recruitment failures. Perhaps the only management necessary at this stage is the prevention of the use of fine mesh nets and destructive methods to catch species, such as mackerel (*Selar* and *Rastrelliger* spp.) which have a longer (2-4 years) lifespan.

Biological data is required to determine strategies with regards to the management of this important fishery.

12.2.4.1 Current legislation/policy regarding exploitation

No legislation exists with regards to the exploitation and management of commercial baitfishing or small pelagic fishing for subsistence and artisanal purposes.

12.2.4.2 Recommended legislation/policy regarding exploitation

Net mesh size for the catching of *Selar* and *Rastrelliger* spp. should be considered. Smaller mesh size nets should be banned.

Any attempt to commercially exploit the baitfishery should proceed only after detailed research on the fishery is completed.

12.3 AQUARIUM FISH (Marine)

12.3.1 The Resource

Background
Between 1.5 and 2 million people worldwide are believed to keep marine aquaria. This trade, which supplies this hobby with live marine animals is a global multi-million dollar industry, worth an estimated US$200-330 million (UNEP-WCMC, 2003) annually, and operates throughout the tropics.

Species present
Species targeted for this undertaking involve those, which are small in size and have bright or ornate colouration. Other important species' features that are considered include non-restrictive diets and overall adaptability to captive environment (Pyle, 1993).

A total of 1,471 species of fish are traded worldwide with the best estimate of annual global trade ranging between 20 and 24 million individuals. Damselfish (Pomacentridae) make up almost half of the trade, with species of angelfish (pomacanthidae), surgeonfish (Acanthuridae), wrasses (Labridae), gobies (Gobiidae) and butterflyfish (Chaetodontidae) accounting for approximately another 25-30 per cent. The most traded species are the blue-green damselfish (*Chromis viridis*), the clown anemonefish (*Amphiprion ocellaris*), the whitetail dascyllus (*Dascyllus aruanus*), the sapphire devil (*Chrysiptera cyanea*) and the threespot dascyllus (*Dascyllus trimaculatus*).

Records of exports from Vanuatu indicate that some of the species (sometimes at juvenile stage) are those that form a portion in the local artisanal and subsistence fisheries. Due to the numerous species involved, species collected for aquarium purposes can be categorized under their families. The more important ones included; *Acanthuridae* (surgeonfishes and tangs*), Balistidae and Monacanthidae* (triggerfishes and filefishes), *Blenniidae and Gobiidae* (blennies and gobies), *Chaetodontidae* (butterflyfishes), *Cirrhidae* (hawkfishes), *Labridae* (wrasses), *Pomacanthidae* (angelfishes), *Pomacentridae* (damselfishes) and *Serranidae* (groupers and basslets).

A recent study, conducted by the Australian Institute of Marine Science (AIMS) on the shallow-water (<30 m) reef fishes in Vanuatu, compiled a check-list of sight records of taxa readily observed by a SCUBA diver (Williams, 1990). A total of 469 species were identified of which 25, under 6 major groups, were easily distinguishable. These include 10 species of *Pomacentridae*, 5 of *Scaridae*, 3 of *Labridae*, 3 of *Acanthuridae*, 2 *Siganidae* and 2 *Chaetodontidae*.

12.3.1.1 Distribution

Ornamental marine species (corals, other invertebrates and fihs) are collected and transported mainly from Southeast Asia, but also increasingly from several island nations in the Indian and Pacific Oceans, to consumers in the main destisnation markets: the nited States, the European Union [EU] and to a lesser extent, Japan. Fish exploited for the aquarium trade in Vanuatu, as is done in other South Pacific islands are all wild-caught marine species from the shallow-water coral reefs surrounding the islands.

12.3.1.2 Biology and ecology

Reef fishes exhibit a wide variety of reproductive strategies. Some fishes, such as many butterflyfishes (*Chaetodontidae*), form monogamous mated pairs. Others, such as the pygmy angelfishes (*Ponacanthidae*, genus *Centropyge*), form polygamous harems consisting of a single male and several females. Still others, such as surgeonfishes and tangs (*Acanthuridae*), spawn in mass aggregations.

Daily, monthly, and annual periodicity in peak spawning times has been demonstrated for many species of reef fishes (Thresher, 1984 quoted in in Wright & Hill 1993). Spawning tends to occur at dusk or dawn, during full or new moon, and with some amount of seasonal variation. Specific

times and strategies vary between different species, and sometimes between populations of the same species in different localities. Actual spawning usually occurs very rapidly, and fertilization virtually always takes place externally.

There are two basic strategies employed by reef fishes with respect to eggs: parental care, and no parental care. Reef fishes, which devote parental care to their eggs, are usually either demersalegg-layers (such as the damselfishes [*Pomacentridae*] and gobies [*Gobiidae*], or mouth brooders (such as cardinalfishes [*Apogonnidae*]). By providing parental care for the eggs, these fishes are able to enhance the offspring survival rate; however, extra time and energy are expended and clutch sizes are smaller.

Most species of coral reef fishes, on the other hand, forgo any parental care and spawn pelagic eggs. Gametes are released in the water column, and the fertilized eggs drift as plankton for some period of time before hatching. Although the eggs are more vulnerable to predation, greater numbers of them are spawned and no energy is expended by the parent in caring for the clutch.

Pyle (1993) gives the following table of some biological and ecological characteristics of the main families in the marine aquarium trade from the South Pacific:

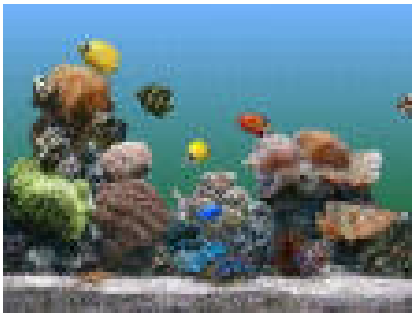
Table 53. Biological and ecological characteristics

Family	Feeding Strategy	Reproductive Strategy	Habitat
Angel fishes (Pomacanthidae)	herbivore/omnivore	harem-forming/pair-forming; some species protogynous; spawn at dusk; pelagic eggs	shallow to deep reef; rubble/coral
Butterfly fishes (Chaetodontidae)	omnivore/plantivore/ corrallivore	pair-forming/school-forming; pelagic eggs	shallow to deep reef; coral and ledges
Surgeonfishes and Tangs (Acanthuridae)	Herbivore	school-forming; spawn at dusk in large groups; pelagic eggs	all habitats, depending on species
Wrasses (Labridae)	Omnivore	harem-forming/school-forming; protogynous; spawn at all time of day (depending on species); pelagic eggs	all habitats, depending on species
Groupers and Basslets (Serranidae)	carnivore/herbivore/ planktivore	harem-forming/pair-forming/aggregate forming; protogynous; spawn at dusk; pelagic eggs	all habitats, depending on species; Anthiinae form aggregation above the substrate
Damselfishes (Pomacentridae)	herbivore/plantivore/ omnivore	harem-forming/aggregate-forming; spawn in morning; demersal eggs	shallow reef coral/rubble; *Amphiprion* inhabit sea anemones
Triggerfishes and filefishes (Balistidae and Monacanthidae)	omnivore	harem-forming/aggregate-forming; demersal sometimes pelagic eggs; some species build nests	all habitats, depending on species; refuge in holes on reef
Hawkfishes (Cirrhitidae)	carnivore	harem-forming; spawn at dusk; pelagic or demersal eggs	shallow reef often in association with coral
Blennies and Gobies (Blenniidae and Gobiidae)	omnivore	wide variety of reproductive strategies, depending on species	all habitats, depending on species

12.3.2 The Fishery

12.3.2.1 Utilization

Recently, the smaller size, bright or gaudy coloured reef fishes, including some of the locally consumed species or their juveniles, have been a target for the aquarium export trade from Vanuatu.



Exports have been made to Australia, New Zealand, U.S.A. and Japan between March 1992 and June 1993 involving, initially, the Vanuatu Marine Exports company in 1992 followed by Aqua-life Exports in 1993. Details on these companies were not available. Earlier reports indicate that the Fisheries Department has been approached on numerous occasions over the last decade to support the development of a fishery to supply the aquarium fish markets in Europe, Australia, America and Asia (Wright, 1989).

12.3.2.2 Production and marketing

The first application for a permit to export aquarium fish, dated June 1993, listed 41 different fish named mainly by their common English names and included: orange anthias, bicolor angels, yellow clownfish, blue damsels, clown surgeonfish, convict tang, coral beauty, lemonpeel angelfish, emperor angelfish (juvenile), false skunk clown, bird nose wrasse, assorted lionfish, pacific sailfish tang, moorish idol, longnose butterflyfish, green chromis, domino damsels, false eye toby, blacksaddled toby, olivacerous surgeonfish, *Naso literatus*, spotted unicornfish, thallassoma X, labroides X, coris X, goby X, purple anthias, jensens wrasse, bicolor chromis, melon butterfly, harlequin sweetlips (juvenile), assorted wrasse, orange axil wrasse, electric blue damsels, tailring surgeonfish, leaf fish, ptereleotris X, and black saddled leopard grouper.

Proper data records of aquarium fish exports commenced in 1992 via application forms for permits submitted by the companies prior to a shipment. Because of lack of proper data collection procedures the numerous species involved were only recorded as numbers of fish and estimated value from each permit application submitted and permit granted. In 1992 a total of 7,590 auarium fish were exported overseas, of which 35.3 percent were exported to New Zealand, 32.8% were exported to Australia, 18.4% exported to the USA markets and 13.5 % were exported to Japan. Total value for all the aquarium fish exported in 1992 was AUS$556,110.00. There was very little export data in 1993. One reason being the effects of the 1993 Civil Servant nation wide strike which resulted in a lot of servces delivered by the Fisheries Department being affected badly. The effects of the strike spilled over to 1994. In 1994 a total of 4,500 pieces of aquarium fish were exported.

Collection is done by companies through agreements with traditional fishing right owners. Aquarium trade appears to be the only industry continuously exporting live fish for the last 10 years surviving the high freight costs and high operating cost in Vanuatu. Export of aquarium fish increase to 70,000 fishes comprising 300 species from 17 families. The 2003 export dominate the overall fisheries export in terms of quantity and value. Live rocks and invertebrates also increase while giant clams decline. About 70% of fish exported originated from Sustainable Reef Supplies company. The estimated contribution the industry made to the local economy is US$1 million, making it the biggest domestic fisheries industry. The table below summarizes the export data from 1992 up to 2004.

Table 54. Aquarium fish export figures for 1992 to 2004

Species	Year	Quantity	Measurement	Value
Aquarium Fish	1992	3,000	Pieces	750,000
Aquarium Fish	1993	4,000	Pieces	1,000,000
Aquarium Fish	1994	4,500	Pieces	1125000
Aquarium Fish	1995	1,850	Pieces	26,060
Aquarium Fish	1996	5,555	Pieces	906,153
Aquarium Fish	1997	16,608	Pieces	747,133
Aquarium Fish	1998	33,945	Pieces	594,104
Aquarium Fish	1999	29,363	Pieces	-
Aquarium Fish	2000	12,490	Pieces	1,856,574
Aquarium Fish	2001	10,051	Pieces	1,528,754
Aquarium Fish	2002	20,749	Pieces	5,803,346
Aquarium Fish	2003	70,000	Pieces	41,522,371
Aquarium Fish	2004	129,793	Pieces	24,214,932

Listed in Appendix 3 are the common fish species that are collected purposesfully by local divers and the aquarium trade operators for the aquarium export. Angelfishes (*Pomacanthidae*) are the most traded family with Flame angelfish (*Centropyge loriculus)* being the main exported species, followed by Wrasses (*Labridae*) goby/blenny (*Gobiidae/Blenniidae*), damselfishes (*Pomacentridae*), butterflyfishes (*Cheatodonidae*) and tangs (*Acanthuridae*). The largest range of species exported are the wrasses. In value terms, Angelfishes are the most valued species contributing 42% of the export value followed by wrasses, others (rare and unusual species), damsels and tangs.

Listed in the table below are, the number of fish species per family found in Vanuatu and targeted by the local aquarium industries.

Table 55. Breakdown by species and families

Families	Common Name	Number of species
Acanthuridae	Tangs	18
Balistidae	Triggers	16
Blenniidae	Blenny	19
Chaetotontidae	Butterfly fishes	21
Cirrhitidae	Hawkfish	6
Gobiidae	Goby	8
Labridae	Wrasses/Hogfishes	80
Lutjanidae	Snappers	7
Monacanthidae	Filefishes	7
Mullidae	Goatfishes	2
Pomacanthidae	Angel fishes	25
Pomacentridae	Clowns/Damsels/Chromis	24
Scaridae	Parrot fishes	2
Scopaenidae	Lion fishes	11
Serranidae	Anthias/Croupers/Bass	17
Siganidae	Rabbit fishes	1
Tetraodontidae	Puffer fishes	15

Table 57. Total Invertebrates aquarium exports from Vanuatu (1997 – 2003)

Year	Invertebrates
1997	230
1998	1200
1999	3000
2000	5000
2001	8000
2002	5000
2003	11000

12.3.3 Stocks Status

Efate island has been the main collection location for aquarium fish products ever since the establishment of the export business way back in the early 1990s. Collection sites around Efate island frequented by divers are outlined on the map below.

Map of Efate Island and off-shore islands showing main collection sites for aquarium products fish.

Williams (1990) notes that there was no strong evidence of any significant human-induced disturbance of the fish communities on their study reefs within Vanuatu. However, some reef disturbances were apparent as a result of cyclones and crown-of-thorns starfish infestation, as well as removal of mangroves and siltation from soil erosion (from logging operations).

Recent assessment surveys by the Secretariat of the Pacific Community in collaboration with the Fisheries Department in 2004, indicated that only two sites on Efate island (Tuktuk II and Hat Island) were affected due to collection of aquarium fish by exporting companies. The rest of the islands within the archipelago have healthy aquarium fish stocks.

12.3.4 Management

Pyle (1993) gives a comprehensive review of literature of the different views on the effects and management strategies of the aquarium trade undertakings in different countries. In small countries like those in the South Pacific where only one operator (exporter) is involved, exploitation guidelines seem to be sufficient.

Apart from the removal of fishes, damage to habitats is perhaps a major concern. This can result from the breaking up of corals either incidentally in the process (anchorage, divers' fins or walking on them) or deliberately to extract a valuable fish specimen hidden in a coral-head. However, the greatest concern involves the use of destructive collecting methods such as sodium cyanide.

12.3.4.1 Current legislation/policy regarding exploitation

Fisheries Regulation 20 prohibits the export of marine fish except with the written permission of the Minister and in accordance with such conditions as he may specify. However, the permission granted under the regulation does not affect any obligation to reach any agreement with custom land owners regarding the use of land and waters for the catching of aquarium fish.

Offences under this regulation is a fine not exceeding VT100,000.

The Fisheries Act 1982 (19) prohibits the use of explosives and poisons to catch fish. Offences under this section is a fine not exceeding VT1,000,000.

The Government in 2000 banned exports of giant clam of species Tridacna crocea from Vanuatu. The ban also prohibited harvest of all species of giant clams on Efate island for aquarium exports.

12.3.4.2 Recommended legislation/policy regarding exploitation

The following are recommended:

- Operators exporting live fish should be licensed and limited to a single operator giving the sole operator a 12-month period of grace.
- Operators should be of a high international repute with a proven record in the trade.
- Involvement of resource custodians in the collection process should be to the maximum extent practicable. There should be a training component in this process
- The use of chemicals or poisons for collection to be prohibited.
- Conservation guidelines to be formulated by the Fisheries Division in consultation with the operator. A ceiling on the total number of fish exported per year to be set, taking into account the area to be fished.
- Efforts should be made to ensure that collection activities do not conflict with other uses e.g. tourist diving.
- The Department of Fisheries should consider reserves, closed-seasons and other conservation measures.
- A quota should be placed for each species of fish exported for aquarium purposes
- Strict management and monitoring mechanisms should be established to ensure compliance with the quota and data reporting.

Appendix 3

Fish Species	Fish Species
Acanthurus lineatus (Clown Tang)	Chaetodon equippum (Saddle Butterflyfish)
Acanthurus nigricans (Power Gray)	Chaetodon mertensii (Mertensii Butterflyfish)
Acanthurus olivaceous	Chaetodon ornatissimus
Acanthurus olivaceous, juv	Chaetodon pelewensis
Acanthurus pyroferus	Chaetodon rafflessi (Lattice Butterflyfish)
Acanthurus strigata	Chaetodon ulietensis
Acreichthys radiatus	Chaetodon ulietensis (Falcula Butterflyfish)
Amanses scopas	Chaetodon unimaculatus (Teardrop Butterflyfish)
Amblygobius phalaena	Chromis sp. (Black Chromis)
Amphiprion chrysopterus	Chromis viridis (Green Chromis)
Amphiprion chysopterus	Chrysipter sp.(Elect Gregory)
Amphiprion clarkii	Chrysiptera sp. (Black Cap Damsel)
Amphiprion melanopus	Chrysiptera starcki (Starcki Damsel)
Amphiprion perioderon (Pink Shunk)	Chrysiptera taupou (Blue Devil)
Anampses neoguinensis	Chrysiptera tricineta (Tricinta Damsel)
Apolemichithyys trimaculatus	Cirrhilabrus exquisitus (Exquisite Wrasse)
Arothron hispidus (White Spot Pufferfish)	Cirrhilabrus pylei
Arothron meleagrisl (Guinea Fow)	Cirrhilabrus rhomboidalis (Rhomboid Wrasse)
Arothron nigropunctata, xanthic Phase (Dogface Goldfish)	Cirrhilabrus rubromarginatus (Ruby Wrasse)
Arothron nigropunctatus	Cirrhilabrus scottorum (Scott Wrasse)
Arothron stellatus (Stellatus Pufferfish)	Cirrhilabrus sp. (Black Fin)
Balistapus Undulatus (Undulate Triggerfish)	Cirrhilabrus sp., Hooded wrasse
Balistoides conspicillum	Cirrhilabrus sp.? Vila Fairy wrasse
Balistoides viridescens (Titan Triggerfish)	Cirrhitichthys falco (Spotted Hawkfish)
Balisttoides conspicillum (Clown Triggerfish)	Cirripectes stigmaticus
Bodianus anthioides (Lyretail Hogfish)	Cirripectes stigmaticus (Indian Blenny)
Bodianus axillaris	Coris gaimard (Red Coris)
Bodianus axillaris (Coral Hogfish)	Corythoichthys intestinalis (Pipefish)
Bodianus bimaculatus (Candy Hogfish)	Ctenochaetus tominiensis (Tominini Tang)
Bodianus diana (Diana Hogfish)	Cyprinocirrhites polyactis (Pixy Hawkfish)
Bodianus loxozonus (Black Fin Hogfish)	Dascyllus aruanus (Three-Stripe Damsel)
Bodianus mesothorax	Dascyllus trimaculatus (Domino)
Bodianus perdito (Banana Hogfish)	Dendrochirus zebra
Bothus sp.	Epinecephalus urodeta
Callopplesiop altovelis (Marine Betta)	Escenius bicolor
Cantherines sp.	Forcipiger flavissimus
Canthigaster bennetti (Bennetti Pufferfish)	Forcipiger Flavissimus (Longnose Butterflyfish)
Canthigaster coronata	Geniacanthus wanatabe
Canthigaster solandri (Blue Dot Pufferfish)	Genicanthus melanopilos female
Canthigaster sp. (Deepwater Pufferfish)	Genicanthus melanopilos male
Canthigaster Valentini (Valentini Pufferfish)	Genicanthus melanospilos
Centropyge aurantius	Genicanthus watanabe, female
Centropyge bicolor	Gomphosus variu (Brown Bird)
Centropyge bispinosis	Gomphosus varius
Centropyge flavicuda	Halichoeres chrysus
Centropyge flavissimus	Halichoeres melanurus
Centropyge flavissimus x, smoky phase	Halichoeres ornatissimus (Ornamental Wrasse)
Centropyge heraldi (Herald's Angelfish)	Halichoeres prospeion
Centropyge loriculus	Heniochus acuminatus (BW Heniochus)
Centropyge multifaciatus	Heniochus varius
Centropyge nox	Hoplolatilus starcki (Blueface Coby)

Fish Species	Fish Species
Centropyge vrolki, Vanuatu golden Var.	Labroides bicolor
Centropyge tibicen	Labridae Family (Assorted Wrasse)
Cephalapholis miniata (Miniata Grouper)	Labroides dimidatus (Cleaner Wrasse)
Cephalopholis miniata	Labroides pectoralis (Multi Cleanerfish)
Cephalopholis urodetaVee Tail Grouper ()	Labropsis alleni
Chaetodon auriga (Auriga Butterflyfish)	Labropsis xanthonota
Chaetodon ephippium	Lepidozygus tapeinosoma
Macropharynogodon negroensis	Macolor niger (Niger Dogfish)
Melichthys vidua (Pink Tail Triggerfish)	Macropharynogodon meleagris (Leopard Blue)
Naso Lituratus (Naso Tang)	Thalassoma lutescens, MD Banana
Naso maculatus	Thalassoma quinquivattum (Rainbow Wrasse)
Naso vlamingii (Vlamingii Tang)	Valenciennea strigata
Neocirrhites armatus	Valenciennea strigata (Sleeper Goby)
Novaculichthys taeniourus	Variola albimarginata (Lyre Grouper)
Novaculichthys taeniourus (Dragon Wrasse)	Xanthichthys auromarginatu (Blue Jaw)
Odonus niger (Niger Triggerfish)	Zanclus canescens
Paracanthurus hepatus (Indo Pacific Blue Tang)	Zebrasoma scopas
Paracheilinus sp. Flasher wrasse	Zebrasoma scopas (Scopas Tang)
Paracirrhites arcatus (Yellow Grouper (Arc Eye Hawkfish))	Zebrasoma veliferum (Sailfin Tang)
Paracirrhites forsteri	Thalassoma lutescens, LG Super Male
Paracirrhites forsteri (Freckled Hawkfish)	Pseudanthias tuka
Paraluteres prionurus (Mimic File)	pseudobalistes fuscus
Parupeneus barberinoides (Bicolor Goatfish)	Pseudocheilinus evanidus (Striated Wrasse)
Parupeneus cyclostomus (Yellow Goatfish)	Pseudocheilinus hexataenia (Sixline Wrasse)
Plectorhinchus chaetodonoides	Pseudocheilinus octotaenia
Plectorhinchus vittatus	Pseudocheilinus sextaenia
Pomacanthus imperator	Pseudochromis porphyreus (Purple Baslet)
Pomacanthus imperator, adult	Ptereleotris evides (Scissortail)
Pomacentrus sp. (Blue Chromis)	Ptereleotris Sp. (Redfin Goby)
Pomocanthus semicirculatus	Ptereleotris zebra
Priacanthus sp.	Ptereleotris zebra (Bar Goby)
Protoreater nodosus	Pterois antennata (Ragged Finned Firefish)
Pseudanthia pleurotaenia	Pterois radiata (Radiata Lionfish)
Pseudanthias lori	Pterois volitans (Volitans Lionfish)
Pseudanthias parvirostris	Pygoplites diacanthus
Pseudanthias pleurotaenia	Rhinecanthus aculeatus (Humu Humu)
Pseudanthias sp.(tri-color)	Rhinecanthus lunula (Lunula Triggerfish)
Scorpaensis sp. (Scorpionfish)	Rhinecanthus rectangulus
Sufflamens bursa	Rhinecanthus verrucosa
Sufflamens chrysoptera	Richardsonicthys leucogaster (Waspfish)
Synanceia verrucosa (Stonefish)	Scarus sp. (Assorted Parrotfish)
Thalassoma lunare (Lunare Wrasse)	Thalassoma lutescens (Lime Wrasse)
Thalassoma lutescens (Banana Wrasse)	

12.4 SHALLOW-WATER REEF FISHES

12.4.1 The Resource

Species present

Fish species accounted for in this section include those that associate with shallow-water reefs, lagoons and mangroves and excludes mackerel and sardines. Species and descriptions of most of the fishes in Vanuatu is given in Fourmanoir and Laboute (1976). The Fisheries Department and ORSTOM are presently compiling a reef-fish species poster of twenty-two species they believe constitute the major commercial reef-fish landings. These include: *Naso lituratus* (orangespine unicornfish), *Kyphosus cinerascens* (highfin rudderfish-topsail drummer), *Epinephelus merra* (honeycomb grouper), *Variola louti* (lunartail grouper), *Scarus blochi* (quoy's parrotfish), *Cheilinus undulatus* (napoleonfish-maori wrasse), *Hemigymnus melaptarus* (blackedge thicklip wrasse), *Plectorhynchus gibbosus* (black sweetlips), *P. orientalis* (oriental sweetlips), *Chaetodon lineatus* (lined butterflyfish), *Lethrinus harak* (blackspot emperor), *L. miniatus* (longnose emperor), *Sargocentron tieroides* (pink squirrelfish), *Lutjanus fulvus* (flametail snapper), *L. gibbus* (humpback snapper), *Mulloidichthys flavolineatus* (yellowstripe goatfish), *Siganus canaliculatus* (seagrass rabbitfish), *S. doliatus* (pencil-streaked rabbitfish), *Acanthurus lineatus* (bluebanded surgeonfish - convict tang), *Shyraena genie* (blackfin barracuda), *Valamugil seheli* (bluespot mullet), *Caranx melampygus* (bluefin trevally) and *Geres oyena* (oyena mojarra).

A study, conducted by the Australian Institute of Marine Science on the shallow-water (<30 m) reef fishes in Vanuatu, compiled a check-list of sight records of taxa readily observed by a SCUBA diver (Done and Navin (Eds), 1990). A total of 469 species were identified of which 25, under 6 major groups, were easily distinguishable. These include 10 species of *Pomacentridae*, 5 of *Scaridae*, 3 of *Labridae*, 3 of *Acanthuridae*, 2 *Siganidae* and 2 *Chaetodontidae* (Williams, 1990).

12.4.1.1 Distribution

Detailed examination of fish communities at Aneityum, Cook Reef, Santo, Gaua and the Reef Islands indicated significance difference amongst the sites although the differences were small compared to those observed for reefs only tens of kilometers apart in the Great Barrier Reef (Williams, 1990). It was also observed that there was no latitudinal variation in structure or species diversity of the communities and no major differences were found between communities on platform reefs and those on fringing reefs. Williams (1990) notes that the south-eastern side of Cook Reef and the eastern side of Santo were particularly rich in fish species and that some species, especially scarids, were more abundant in these areas.

David and Cillaurren **(**1989**)** presented the following table on the area distribution of the reefs in Vanuatu down to 400m:

Table 58. Area distribution of reefs in Vanuatu down to 400 m

ISLANDS	SURFACE AREA (ha)				
	Land	Shelf	10-100m	100-400m	Total Reef Area
Torres	12,000	1,600	26,130	20,600	48,330
Ureparapara	3,900	289	1,650	5,150	7,080
Vanua Lava	33,000	1,640	6,500	16,390	24,530
Mota	1,500	110	850	3,170	4,130
Mota Lava	3,100	570	2,450	4,120	7,140
Mere Lava	1,500	30	550	1,780	2,360
Gaua	33,000	1,510	3,280	16,990	21,780
Rowa	10	2,630	1,700	4,270	8,600
Santo-Malo	424,800	4,500	60,000	142,970	207,470
Ambae	41,000	230	3,850	11,840	15,920
Maewo	28,000	780	6,030	33,470	40,280
Pentecost	49,000	1,730	8,950	25,000	35,680

Malekula	205,300	10,110	45,100	101,350	156,560
Ambrym	66,500	700	7,250	26,650	34,600
Epi-Paama-Lopevi	47,800	2,500	19,130	76,510	98,140
Tongoa-Tongariki	5,000	150	4,720	16,530	21,400
Emae-Makura-Mataso	3,600	2,020	4,660	30,820	37,500
Efate	92,300	8,070	28,450	95,330	131,850
Erromango	88,700	1,340	4,250	55,660	61,250
Tanna	56,100	1,310	7,450	42,440	51,200
Aniwa	800	310	1,150	5,120	6,580
Futuna	1,100	100	1,400	3,700	5,200
Aneityum	16,000	2,580	18,450	14,820	35,850
TOTAL	1,218,900	44,800	263,950	754,680	1,063,430

12.4.1.2 Biology and ecology

Ecological characteristics of some of the fish families in this category is given in Pyle (1993) as follows:

Table 59. Ecological characteristics of reef fish families

Family	Feeding Strategy	Reproductive Strategy	Habitat
Acanthuridae (surgeonfishes and tangs)	Herbivorous	school-forming; spawn at dusk in large groups; pelagic eggs	all habitats depending on species
Labridae (wrasses)	Hebivorous	harem-forming/school forming; protogynous; spawn at all times of day depending on species; pelagic eggs	all habitats depending on species
Serranidae (groupers and basslets)	Carnivorous/ Herbivorous/ Planktivorous	harem-forming/pair-forming/aggregate-forming; protogynous; spawn at dusk; pelagic eggs	all habitats depending on species; Anthiinae form aggregations above the substrate

Sexes are separate in most shallow-water reef-associated fishes including holocentrids, mugilids, mullids, gerrids, siganids, carangids (Wright, 1993). Protogynous (change from female to male) fishes include serranids, lethrinids, nemipterids and labrids while platycephalids, sparids, gobiids and muraenids change sex from male to female (protandrous). Most species produce pelagic eggs except for the majority of siganids, tetradonids and balistids which nest. Spawning migration, to a reef location contiguous to oceanic water, vertically in the water column or inshore, is common (Wright, 1993).

12.4.2 The Fishery

12.4.2.1 Utilization

The reef fishery has been the main source of fish protein on the subsistence level. The change to a cash-based economy, improved and introduction of modern fishing gears have further increased the pressure on these very important but potentially vulnerable resources. The methods employed range from mere collection by hand to gill netting on the reef, set or surround net and diving using spear guns. Local fishermen prefer spear gun particularly for night diving especially when spear-fishing for parrot-fish.

David (1989) differentiated shallow-water fish from deep-sea fish by the ability to see the bottom of the fishing grounds. Thus shallow-water fish are found in areas where the bottom is visible and include reef flats, upper parts of reef slopes, beaches and mangroves with reef flat being the most intensively fished area.

Subsistence village fishing, concentrating mostly around the reefs, has been widely considered secondary to agriculture in Vanuatu. Grandperrin (1977) did not even mention reef fish in his general inventory of the fisheries resources of Vanuatu. However, the village subsistence survey carried in 1983 indicated that throughout the country, half the population, from 8,600 households, was estimated to be involved in some form of fishing activity (David and Cillaurren, 1989). Except for the few villages that are located inland (mostly in Santo and Malekula) all of the fishing households live near the coast, which is about 70% of the population. Throughout the

archipelago, Malekula, the Banks group, Efate, Santo, Pentecost and Tanna constitute the major fishing population centres. In describing the reef resource exploitation, David (1990) noted that "fishing is simply a side-line, either for commercial purposes, to bring in extra money for the household in order to meet particular expenses such as taxes, school fees, celebrations; or for subsistence purposes, in which case fishing activity is a regular operation, and only the surplus is marketed". Apart from the fin-fish resource, species collected mostly for their commercial value from the reefs include trochus, green snail and sea cucumber. These are treated separately under their individual profiles.

Up to the late 1980s and early 1990s fishing in the reef zones in Vanuatu was still generally steeped in tradition, using age-old ways and means of fishing and generally limited to the shallower areas of coastline, the intertidal zones and infratidal zones, less than 10 metres deep, and to the coastal zones sheltered from the swell. Fishing boats used in these zones were mostly traditional canoes with paddles. The reef flats were easily reached on foot. The collection of mollusc was normally done by the women. Fishing methods used included; assegai or spears, bows and arrows, cast nets, fish fences and traps, fishing reel, gill nets, handlines, poisoning using leaves and under-water spearguns (David, 1990).

During the mid 1990s there was a dramatic change in rural fishing methods. There were more boats powered by either 15 or 25 Hp outboard motors. Prefered fishing methods included; cast nets, gill nets, under-water spear guns, fishing reels, and handlines. Fin-fish catches from the reefs became a common commodity in the fish markets. Fin fish which used to be caught for mainly subsistence are now caught for commercial purposes. This change is driven the cost of living and the need to generate rural income to cover such costs as school fees, school uniforms, etc.

12.4.2.2 Production and marketing

No recent estimate of the contribution of the shallow waters reef-fish to the subsistence as well as the local market sectors has been made. However, a survey of village fisheries production was estimated for 1983 as part of the country's agriculture census. A comprehensive report was produced on this and the results are presented in David (1985). David (1989) summarized the annual village fishing sector production (confidence interval:1,920-3,011) from that survey to be 2,402 tonnes, consisting of:

Table 60. Village fishing sector production

Item	**Percentage**
Fish	42.5
Shellfish	33.5
Lobster	20.5
Octopus	3.0
Fresh-water prawns	0.5

Details of the 1983 survey results, including portion sold and value, as presented by David (1985 and 1989) are as follows, including deep-sea fish.

Table 61. Details of the 1983 survey results

	TOTAL PRODUCTION		**PRODUCTION SOLD**			
Product	Number	Weight (tonnes)	Number	Weight (tonnes)	% total production	Value 10^6 vatu
Deep-sea fish	1,430,000	572	307,500	123	21.5	9.8
Shallow-water fish	3,980,000	398	1,114,000	111.5	28	8.9
Fresh-water fish	963,500	48	132,000	7	14	0.5
Octopus	331,800	66	52,000	10.5	15	1.5
Lobsters	981,000	490	498,400	250	51	125
Marine shell-fish (baskets)	202,600	810	13,400	53.5	6.5	1.6
Fresh-water prawns (baskets)	9,000	18	-	-	-	-
TOTAL		**2,402**		**555**	**23**	**147**

Note: -no sales of fresh-water prawns was recorded in the survey.

Records of reef fish sold to the former Fisheries Department Extensions Centers on the outer islands for the period from 1990 to 1992 were given as "mixed reef fish" and is shown in Table 62. However mullet is recorded as a separate category. The table also includes shallow reef fishes purchased by the Natai Fish Market, also lumped under a label ("reef-fish") in the Fisheries Department Database (figures in kg).

Table 62. The purchases of reef fish by the Natai and Fisheries Extension Centres.

	Natai Market		**Fisheries Extensions**	
	Reef-fish	Value (Vatu)	Mixed reef fish	*V. seheli*
1988	34,064.0	7,708,089	-	
1989	6,492.0	1,086,295	-	
1990	12,881.6	1,973,169	2,679.8	524.7
1991	20,909.1	4,993,410	4,477.3	2,339.1
1992	24,074.2	6,137,480	7,862.0	1,422.6

The "mixed reef fish" sold through the Natai Fish Market from 1988 to 1992 were made up mostly of parrot-fish (recorded as "blue fish"), a few surgeon-fish (Acanthuridae) and goatfish (*Parupeneus*) which were sold at VT 360 per kg.

Santofish Market sales of reef fish (excluding inshore pelagics, sardine and mackerel, which are discussed under Profiles for Baitfishes-small pelagics) between 1989 and 1992 are recorded in Table 63 below. Mullet is composed almost exclusively of *V. seheli*. The combined records show increasing totals from this component of the total fish landing. (Figures are in kg.).

Table 63. Sales of reef fishes at Santofish (1989 – 1992)

	1989	**1990**	**1991**	**1992**
Trevally (caranx)	340.8	1,518.9	821.3	656.3
Rabbitfish	0	4.1	2.0	764.4
Mullet	122.5	204.9	491.7	2,155.7
Reef fish	3,457.2	8,828.8	11,219.0	10,122.5
Total	3,920.5	10,556.7	12,534.0	13,698.9

In addition to the shallow reef fin-fish the Natai Fish Market also purchased reef crabs and mud crabs as shown below for the 1988-1992 period (source: Fisheries Department Data Base).

Table 64. Reef crab and mud crab sales (1988 – 1992)

	1988	**1989**	**1990**	**1991**	**1992**
Reef Crab (kg)	51.9	22.5	8.6	11.3	0
Value (VT)	7,943	4,170	2,290	2,663	0
Mud Crab (kg)	0	7.5	22.5	13.6	65.5
Value (VT)	0	2,550	10,625	4,760	39.300

Au Bon Marche super market was the only other commercial outlet in Port Vila that sold fish from the early 1980s until present. In 1992 an estimated 1,000 kg of reef fish, including sardines and mackerel, were sold via this supermarket during.

Following the closure of both Santo fish and Natai fish markets, in 1997, data collection of reef fish production has been very poor. The Department of Fisheries only concentrates on collecting pelagic and deepwater bottom fish data, which are provided by fishing projects via the GRN forms. Reef fish data records from the Department's data collection base are incomplete. Summarize below are reef fish sales for the years 2001 to 2003 by Sanma Fish Market.

Table.64. Reef fish sales (2001 – 2003)

	2001		**2002**		**2003**	
Species	**KG**	**VT**	**KG**	**VT**	**KG**	**VT**
Mix reef fish	627.3	153,484	96	19,330	635	208055
Mullet	24	4800	34	6800		
Rabbit fish	-	-	5	1250		

Even though data collected by the Department indicated that reef fish production to be very small, due to poor data collection, the reality is that reef fish production is increasing every year, given its commercial at the urban markets. Production by fish outlets such as LTP, and Au Bon Marche indicates an icrease in reef fish production, particulalarly of rabbit fish, parrot fish, snappers and mullet.

Table 65. Local Fish Market sales of reef fish - 2004

	2004	
Species	**KG**	**VT**
Mix reef fish	15,767	3,012,495
Sardine	46.5	6,975
Loche	5	750
Trevally	28.2	4,275
Parrotfish	151.9	30,300
Mangru	64	13,056
Total	**16,062**	**3,067,851**

Note that the 2004 figures are not complete due to the fact that some fish markets refused to supply regular data to the Fisheries Department, even when they do, the figures are under reported. A possible reason could be that fish markets do not want the Fisheries Department to know how much money they are making through retailing of reef fishes and fish in general.

It is important to note that given the transportation difficulties to enable fish to be sold at the fish markets, reef fish caught by rural fishermen and fisherwomen are often sold at the urban municipal markets in fish boxes. Data from these sources are not collected. It is envisaged that now with the re-establishment of community based Ice machine projects, fish data can be collected much more readily. An example being the Emae ice machine project which was opened in September of 2004. Since its operation in September 2004 to December 2004 a total of 2,738 Kgs of reef fish were purchased from the Emae rural fishermen and fisherwomen and transported to Port Vila for sale at a private residence resulting in a total of VT451,770 injected into the rural communities around Emae island.

Reef fish caught by a rural fishermen being weighted at the Emae ice machine center

Rural fisherman using private residence in Port Vila as market outlet for reef fish purchased from rural communities

Artisanal Fishing projects scattered throughout the islands of Vanuatu, especially those off shore islands closer to and including Efate and Santo islands, contribute immensly to rural production and injection of much need cashflow into the rural economy. Listed in the table below are fish caught by artisanal fishing projects in 2004. However, data is incomplete due to two factors. First being that some fishing projects were not able to send in their catch data sheets, and second, the Department of Fisheries has not yet completed entering the 2004 data sheets supplied by artisanal fishing projects.

Table 66 Artisanal production in 2004

Species Name	Quantity (Kg)	Value (VT)
Wahoo	206	72700
Yellow Fin	1106	166535
Skipjack	1059.5	285400
Mahi Mahi	15	7500
Dogtooth Tuna	67	13400
Rainbow Runner	17	3460
Marlin	43	13000
Red Short Tail	1596	515475
Red Long Tail	485	271475
Red Silver Jaw	74	33900
Large Scaled Jobfish	360	202000
Yellow Jobfish	751	337950
Pink Tail Jobfish	142	63900
Spotted Loche	10	1800
Brn. Striped Loche	33	8250
Large Eye Bream	17	5100
Kusakars Snaper	36	10800
Amberjack	109.5	31550
Sea Perch (Snapper)	45	13530
Silver Jaw	139	62550
Other	13	2600
White poulet	62	13640
Snapper	20	4400
Total	**6,406**	**2,140,905**

Source Fisheries Department

12.4.3 Stocks Status

No information is available that attempts to assess any species stock of the reef fish resources in Vanuatu. Compilation of data by the Fisheries Department makes it impossible to trace any trends of individual species. Detail record keeping of landings of the more important species can be initiated. This data can be generally used to determine trends occurring within the status of the stocks. Williams (1990) found no significant human-induced disturbance of the fish communities in those reefs that they studied. However, most reefs examined showed evidence of major disturbances by cyclones and/or crown-of-thorns starfish.

Given the recent population increase particularly in the rural areas, the need to generate income to meet the current high cost of living, the fishing pressure on reef fish has increased especially on Efate, Santo and Malekula. This is because of the ease of access to urban markets.

12.4.4 Management

It is only on very rare occasions that dynamite is used to catch fish. Target species include mullet, mackerel, goatfish and topsail drummer schools. However, regulations against dynamite use seem to be widely observed within Vanuatu. Increases in population generally lead to increasing pressure on this more easily accessible resource. Over-exploitation always follows. Growth in the use of more efficient modern fishing gears is apparent and the decline in fishing effort for the deep-water fishery could result in a shift of pressure to shallow-water fishes.

12.4.4.1 Current legislation/policy regarding exploitation

The use of explosives and poisons for fishing is prohibited under the Fisheries Act 1983 [CAP. 158].

12.4.4.1 Recommended legislation/policy regarding exploitation

There is some concern on the unregulated use of gillnets utilized in this fishery especially over the reefs. Consideration should be given to setting minimum mesh size limits. The use of speargun and under-water flashlight at night is believed to be very effective on certain species, especially parrotfish, which is the main target species of this method.

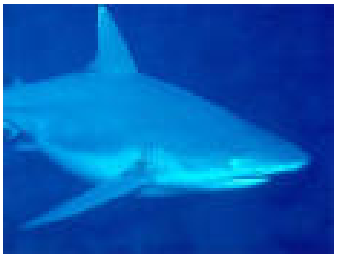
The following recommended policies for immediate implementation should be considered:

1. Gillnet mesh sizes should be regulated,
2. Night diving using spear guns and under water flash lights should be banned,
3. The provincial governments in collaboration with the Department of Fisheries and the Environment should identify and establish marine reserves.

13. CHONDRICHTHYES

13.1 SHARKS

13.1.1 The Resource



Species

The cat shark (*Scyliorhinus torazame*), hammerhead (*Sphyrna* sp.) and shortspine spurdog (*Squalus mitsukurii*) were identified during OFCF project between 1984 and 1986. Sharks caught during several SPC deep-bottom fishing expeditions in Vanuatu also recorded *Carcharhinus albimarginatus* (silver-tip shark) and an unidentified species in the catches (Dalzell and Preston, 1992). Other species are listed in Fourmanoir and Laboute (1976).

13.1.1.1 Distribution

Smith (1992) notes that sharks occur from the reef and inshore areas through to the open oceans, at all depths.

During the OFCF project mentioned above, observations were made of many species of large size sharks in and around the entire coastal water areas of Santo, particularly around the FADs. In a lot of cases during the catch hauling operations in trolling, predation by sharks (and sometimes by barracuda) took place. *S. mitsukurii* were particularly plentiful around FADs.

13.1.1.2 Biology and ecology

Compagno (1984)(a) and (b) gives some information on habitat, distribution, biology and ecology of the known species of sharks in the world. For reproduction, a variety of modes are utilized but fertilization is internal with most species bearing their young alive in broods ranging from a few individuals to nearly one hundred (Smith, 1992). Sharks are generally slow growing.

13.1.2 The Fishery

13.1.2.1 Utilization

Shark meat is marketed commercially in the local fish market in Port Vila. Consumption of shark meat is common in the subsistence level. A limited amount of shark fin has been exported.

Currently, shark is a by-catch of the deep-water bottomfish fishery. However, some fishermen set out a specially designed line to catch sharks either as a hobby or for commercial purposes. Records of the SPC deep-bottom fishing trials in Vanuatu indicated that shark made up a very minor portion of the catch (Dalzell and Preston, 1992).

In October of 2003 the Department of Fisheries issued up to 6 fishing licenses to 6 locally based foreign fishing vessels to fish for sharks in Vanuatu waters. The licenses were valid for a period of 12 months.

13.1.2.2 Production

Catch composition of bottomfish catches landed by Fisheries Department vessels in 1983 and 1984 comprised of 9.6% and 16.06% of shark (by weight) respectively. During mid-water long line fishing trials for large yellowfin tuna by OFCF around FADs from October 1985 to June 1986 comprising of 30 fishing operations, 10 sharks were caught.

From 1988 to 1992, the sale of shark meat at the Natai Fish Market was the only source of data where shark is sold. The table below summarizes annual shark purchases and value for the Natai Market from 1988 to 1992 (source: Fisheries Department Data Base). Between May 1983 and July 1984, 4,379 kg were purchased by Natai while only a small quantity was recorded by Santofish at about the same time (Crossland, 1984).

Table 67 Annual shark purchases and value for the Natai fish market (1988 – 1992)

	1988		1989		1990		1991		1992	
Species	kg	Vt	kg	Vt	kg	Vt	kg	Vt	kg	Vatu
Shark	1,138.6	61,342	725.5	53,200	851.8	63,621	1,289.7	126,008	758.9	77,927

Data for 1993 – 1995, 1998, 1999 and 2002 are not complete. This is because catch data for sharks for these years were included as part of Mixed-reef fish data records. The table below summarises catch records by artisanal fishing projects for the years 1996, 1997, 2000, 2001, and 2003.

Table 68 Shark production by artisanal fishing projects

Species	1996 (kg)	1997 (kg)	2000 (kg)	2001 (kg)	2003 (kg)
Sharks	190	586.3	750.8	11,307	1,102

Following the commencement of the operations of the 6 locally based foreign fishing vessels in October 2003, fishing for sharks as the target species, a total of 3 transshipments were made between October 2003 and August 2004. Summarized in the table below are the quantities of sharks transshipped in Port Vila Habour by six licensed locally base foreign fishing vessels.

Table 69 Shark catch by 6 locally base foreign fishing vessels

Date	Quantity (kg)	Value (US$)
24 February 2004	122,900.0	61,450.00

Records pertaining to the export of shark fin from Vanuatu, is presented in the following table.

Table 70 Shark fin exports from Vanuatu

Year	Quantity (kg)	Value
1980	10,700	US$59,950.00
1981	14,000	US$71,520.00
1982	5,000	US$25,910.00
1983	9,000	US$47,220.00
1984	22,000	US$46,000.00
1985	11,000	US$70,570.00
1986	5,000	VT2,282,000
1987	Data not available	-
1988	No data records	VT50,000
1989	No data recors	VT14,000

The high export quantities of shark fins during the early to mid 1980s is attributed to the operation of the South Pacific Fishing Company in Palekula, Santo. From 1990s onwards there were no significant exports of shark fins. Summarized below are recent records of shark fin exports.

Table 71 Shark fin exports (1998, 2001 – first half of 2004)

Year	Quantity (kg)	Value (VT)
1998	30	349,440
2001	12	-
2002	22	147,160
2003	478	1,786,316
2004 (Jan-Jul)	15	50,460

In 2001 a total of 686 pieces of shark teeth were also exported

13.1.3 Stocks Status

No information is available on the stocks of sharks in Vanuatu. However, catch data provided by the locally base foreign fishing vessels seem to indicate that the shark population in Vanuatu waters are still plentiful.

Observations elsewhere indicate that because of their generally slow growing, populations can be greatly reduced by heavy fishing. Randall *et al* (1990, quoted in Smith 1992) noted that removal of these top level carnivores from a community such as a reef system, results in adverse effects.

13.1.4 Management

13.1.4.1 Current Legislation/Policy Regarding Exploitation

There is no existing legislation concerning the management of the exploitation of sharks in Vanuatu waters.

13.1.4.2 Recommended Legislation/Policy Regarding Exploitation

Given the quantity of shark trunks transshipped by the six locally base foreign fishing vessels and the importance to sustainably manage the shark resource, it is vitally essential that the Department of Fisheries develop management criteria for harvesting of the resource.

An urgent policy is needed to ban commercial fishing of sharks until the Department of Fisheries in collaboration with other relevant government and private sector agencies develop a sound management plan for the shark fishery.

14. FLORA

14.1 MANGROVES

14.1.1 The Resource

Because of the important role the mangroves contribute to the coastal fisheries resources, they are treated as a resource for these profiles.

Species present
Lal and Esrom (1990) lists 13 major mangrove tree species (in eight families) recorded in Vanuatu. They include, *Heritiera littoralis, Exocecaria aqallocha, Xylocarpus qranatum, Ceriop tagal, Rhizophora stylosa, R.. mucronata, R.. apiculata, Bruquiera gymnorhiza, B. parviflora, Avicennia marina, Sonneratia caseolaris, S. alba* and *Lumnitzera littorea*.

14.1.1.1 Distribution

David (1985) estimated that mangroves cover an area of 3,000 ha (+/- 500) for the whole of the Vanuatu archipelago. Of the 80 islands in Vanuatu, only 9 have any extensive growth of mangroves and apart from Malekula, mangroves are found in small clumps scattered along low energy coastlines (Lal and Esrom, 1990). Malekula is the only island which has extensive growth of mangroves found along the shorelines protected by fringing reefs, smaller islands and peninsula protecting bays. David and Cillaurren (1989) gave the following table (Table 70) on the area distribution of the main mangroves in Vanuatu:

Table 71 Area of distribution of mangroves in Vanuatu

	Mangrove Area			
Island	**(ha)**	**Percentage**	**Area of Island**	**Mangrove area to Island (%)**
Malekula	1,975	78.0	205,300	1.0
Hiu	210	8.5	5,280	4.0
Efate	100	4.0	92,300	0.1
Emae	70	3.0	3,280	2.1
Epi	60	2.5	44,500	0.1
Vanua Lava	35	1.5	33,100	0.1
Ureparapara	30	1.0	3,900	0.8
Mota Lava	25	1.0	3,100	0.8
Aniwa	15	0.5	800	1.9
Total	**2,460**		**391,560**	**0.6**

Approximately 86% of the country's mangroves are located on Malekula and Hiu in the Torres group of islands. However, Emae and Aniwa islands are also well endowed since mangroves on each island represent 2% of their respective land masses (David and Cillaurren, 1989).

14.1.2 Mangrove and Associated Fisheries

14.1.2.1 Utilization

Results of a preliminary survey by Lal and Esrom (1990) indicate that mangroves play an important role in the local subsistence and semi-subsistence economy, particularly in areas where extensive concentrations of mangroves are found. Subsistence use of mangroves for firewood, mangrove crabs and finfish is significant as shown by a survey of eleven villages situated within or in close proximity of the mangrove ecosystem in the Port Stanley on Malekula and on the adjacent

islands of Uripiv, Uri and the Maskelyn. Villages actually situated within the mangroves on smaller offshore islands such as the Makelynes are almost entirely dependent of mangroves for firewood.

Mangrove dependent fisheries products are commonly harvested and villages located within and close to mangroves rely on these ecosystems for their subsistence fishing.

14.1.2.2 Production and marketing

The average consumption of firewood by villages surveyed by Lal and Esrom in 1990 is given in Table 73.

Table 73 Statistics on mangrove firewood consumption during the May 3-19, 1990 survey

Village	Number	Range (bundles per month)	Average (bundles per month)
Potnambe	3 (12)	2-12	7
Potindir	3 (10)	-	negligible
Litzlitz	11 (42)	2-20	8
Arbotan	3 (5)	6-10	8
Molku	3	-	negligible
Uri	5 (7)	8-24	15
Vilavi	8 (11)	2-8	4
Potun	4 (9)	2-3	2
Tevri	5 (17)	2-7	3
Peskarus	16 (81)	8-20	12
Pellonk	10 (40)	10-20	15
Penap	NA (18)	-	NA
Rambuan	NA (14)	-	NA

On Uliveo Island, an average of 15-24 bundles of mangrove wood per month per household is burnt as fuelwood. Using an average wet weight of 20 kg per bundle, Lal and Esrom (1990) estimated an annual consumption of mangrove wood to be 3,600-4,800 kg per household. In Port Stanley Bay region on Uri, the monthly mangrove fuelwood consumption range between 8 and 24 bundles (160-480 kg) per household.

The common finfish species targeted in the mangrove areas include mullets, rabbit fish and goat fish. In the Maskelyn islands, David (in press, quoted in Lal and Esrom, 1990) noted that 66 species of finfish were caught regularly from the mangrove areas of which 29 species were exclusively caught there. Subsistence consumption of fish products was estimated to be 10 kg per month per household (Lal and Esrom, 1990). However, the proportion from the mangrove areas was impossible to estimate. Production of the land crab, *Cardiosoma* sp. for both subsistence and for sale in the Port Stanley area is reported under the Land Crab Profile. Another important fishery, reported for the Port Stanley region and on the Maskelyne islands is the mangrove crab, *Scylla serrata*, which is often specifically caught to supply restaurants in Port Vila. One household from each of Uri and Uripiv were known to catch crabs on orders from restaurants in Vila. No production figures were available. David (1989) estimated that the annual fish production from mangroves and shelves, in numbers, is 3,963,200 as compared to 1,447,300 from the outer slope (10-400m). Productions in numbers per hectare were then estimated to be 80 and 1.5 respectively for the two areas.

14.1.3 Mangroves Status

Lal and Esrom (1990) note that the pressures on the mangrove resource from development is small due to their being distant from main urban centres. However, development for tourism has resulted in some reclamation on mangrove areas on Efate and adjacent islands and Iruiti island. Clearing of about 100 m of mangroves in Port Stanley was caused by the extension of the wharf on Malekula to accommodate the needs for a logging project. In the rural areas indiscriminate harvesting of mangroves for fuelwood, increasing village sizes and clearing for easier access to the sea present some problems. These have been noticeable in villages in Port Stanley and Crab Bay, and on Uliveo island. The entire coast of Uliveo island is believed to have had a fringe of mangroves in the 1940's. The northern side has been replaced by a sandy beach.

14.1.4 Management

Systematic management of mangroves does not exist in Vanuatu and the government relies on existing institutional mechanisms to address mangrove management issues arising from development on custom land (Lal and Esrom, 1990). Any development on custom land requires the non-owners to obtain a lease from custom land owners. Negotiation of leases on tourism development, forestry, agriculture etc. is handled by the Ministry of Lands. Proposals for physical development involving actual alienation of land for a period of time (e.g. hotel development) are deliberated by the Rural Alienated Lands Committee (RALC). Environmental Impact Assessment (EIA) is required for large-scale projects. However the EIA requirement is not currently based on any legislation. A lease is issued subject to restrictions stipulated by the Ministry of Lands and a number of covenants have been developed. Under the Land Lease Act 1983, one of the covenants included in the standard form of commercial lease is the provision that the commercial leasee agrees not to fell or otherwise destroy mangroves growing on the stated land or in the sea contiguous thereto.

14.1.4.1 Current legislation/policy regarding exploitation

Commercial harvest of mangrove forest products is totally banned. Even though the government does not have a formal policy on commercial logging of mangroves, the Environment Unit has adopted an informal policy of not allowing commercial logging of mangroves or large scale reclamation of mangrove areas for alternative uses (Lal and Esrom, 1990).

14.1.4.2 Recommended legislation/policy regarding exploitation:

The following recommendations should be considered by relevant institutions,

- There should be a ban on harvests of Mangroves in Vanuatu
- Developers should be banned from destroying mangrove areas to build hotels
- Carry an assessment survey of Vanuatu's Mangroves

15 MOLLUSCS

15.1 TROCHUS

15.1.1 The Resource

Species present:
The top shell, *Trochus niloticus*, and *Tectus pyramis* are present.

15.1.1.1 Distribution

The distribution of trochus is dependent on the presence of coral reefs. Trochus niloticus is found in the tropical and subtropical waters of the eastern Indian and western Pacific Oceans. It natural distribution extends from Sri Lanka in the west (Rao, 1936) to Wallis island in the east (Gillett, 1986a). The edge of its natural habitat in the Western Pacific was marked by an oblique line running from Palau down to Wallis. The northern limit of its range is the Ryukyu islands of southern Japan (Hedley, 1917), while its most southerly extent is New Caledonia (Bour *et al*., 1982) and the Swain Reefs complex at the southern end of the Great Barrier Reef, Australia (Moorhouse, 1933).

Translocations of *T.niloticus* to places where they do not naturally occur have, in many cases, been remarkably successful. An example is the successful translocation of trochus to a pass on the windward side of Tahiti took place in 1957, when 40 of 1,200 trochus survived the journey from Vanuatu (Savat and Rives, 1980; Gillett, 1986a). The stocks were not fished for 17 years. On the basis of an estimated biomass of 2,500 tonnes in 1971 (yen, 1985), it was estimated that the initial population of 40 increased by an average factor of 2.3 annually between initial transplant and first harvest (Nash, 1985)

In Vanuatu, *T. niloticus* occur naturally and are generally spread throughout reefs with suitable habitats.

15.1.1.2 Biology and ecology

Trochus niloticus Linnaeus, 1767 is a member of the family Trochidae, a large family of marine gastropod mollusc containing several hundred species. The family Trochidae is itself a member of the Archaeogastropoda, the most primitive order of the prosobranch Gastropoda. It shares this order with the turban shells (*family Turbinidae*) and the abalones *(family Haliotidae*). These families share many life history features; they are all herbivores, feeding on either turf or fleshy algae; they release their gametes (eggs and sperm) directly into the sea, where fertilization occurs; the eggs are lecithotrophic (contain yolk), and the plantonic larval phase is short (no more than a few days).

T.niloticus occurs in two different growth forms, which have at times been considered two separate species (Allan, 1947 quoted in Wright & Hill 1993). One form is conical, with straight sides and flat base. In the second form, the final whorl of the shell expands greatly to form a wide basal flange. The conical form has been described as *Trochus maximus* Koch and the flanged form as *T. niloticus* Linnaeus (Dodge, 1958).

T. niloticus has a large, thick, heavy, conical shell, pinkish in colour with dark, reddish brown blotches. It is the largest species in the genus, and may exceed 15 cm in basal length. Trochus inhabits shallow, sunlit waters rarely being found deeper than a few metres. The maximum densities of trochus suitable for harvesting are found on the first meters of the outer reef slope which is made up essentially of massive slabs of dead coral (Marchandise, undated). Trochus is primarily herbivorous, feeding on small algae, diatoms and foramaniferas on dead coral and rock surfaces. A trochus radula is estimated to comprise of about 150 teeth. This enables it to graze. In the stomach content of 20 specimens, ranging from 60 to 75 mm in diameter, Asano (1944)

found Foramanifera, Cyanophyceae, and Phaeophyceae in large quantities and also a lesser proportion of other small red and green algae mixed with a large quantity of sand (Asano, 1944).

Trochus do not have secondary external sexual features by which the sexes can be distinguished. The only definite method to determine the trochus sex is to break the apex of the shell to reveal the gonad which, when mature, is a deep green colour in the female and milky white in the male. However, another method of determining the sex of an adult trochus without sacrificing it is to force the living trochus to retract far into its shell by pressing with one's thumb on the operculum. This will cause the animal to eject some water in the paleal cavity; if the water is examined under a microscope it will usually be found to contain some spermatozoa and sometimes some green ovocytes. This method is usually reliable during the spawning season when selecting genitors to obtain spawn for aquaculture.

Sexual maturity is reached in the second year (size 5-6 cm). Spawning occurs throughout the year in Vanuatu, at night during few days before new moon or few days after new moon. Male and female gametes are released into the sea where fertilization takes place. The fertilized eggs are covered with a thick chorion which protects the embryo. After hatching, the trochophore develops a larval shell (the protoconch) and swims towards the surface using the ciliated velum. At this stage it has become a lecithtrophic veliger. After a few days, the veliger settles on a substrate, sheds its velum and begins to crawl along on its single foot feeding on microscopic algae.

The number of eggs release by a female trochus depends on the size of the shell (basal length). Heslinga (1981) estimated that one female of 10 cm diameter can release up to 2 million ovocytes, while Nash (1985) stated that females in the 86-100 mm group can release an average of 1 million ovocytes (Nash, 1985). Bour (1990) sampled 596 mature females and found the following average fecundity per size class:

Table 74 Average fecundity per trochus size

Average Diameter (in cm)	**70**	**80**	**90**	**100**	**110**	**120**	**130**
Average fecundity (X 1000)	511	562	592	660	690	974	3003

Trochus growth depend very greatly on environmental factors such as water temperature, quality of the substrate and available food.

15.1.2 The Fishery

15.1.2.1 Utilization

Collection of trochus for its protein-rich flesh has been a traditional activity on the islands for a long time. However, since the end of the 19th century, the sale of trochus shells for its pearl-shell had become apparent in Vanuatu. French settlers were reported to have harvested trochus for the shells in Vanuatu at the beginning of the 20th century. Commercial harvesting is likely to have started during the 19th century with the rise of the bêche-de-mer industry, not only in Vanuatu but also the rest of the Pacific. At present, trochus is one of the major inshore resources in the Republic generating incomes for the rural communities. The major uses are for the local production of button blanks, shell jewellery and other artefacts. Shell exports are mainly to South Korea and Japan (Kenneth, undated). World demand for pearl-shell has increased considerably since 1989.

Trochus shells are collected throughout Vanuatu, by hand on the reef by rural fishermen diving with goggles or face mask. Extraction of trochus meat is done after shell has been boiled. The extracted meat is consumed as a source of protein while the shell is sold.

T. pyramis, which is widely distributed in the Vanuatu waters, is also utilised on a subsistence level for food. The shells are sometimes sold as ornaments to the tourists.

15.1.2.2 Production and Marketing

Trochus shells are processed into button blanks for the high quality garment industry. Japanese companies are the leaders in this sector and thus set the price trends for the products. Vanuatu shell factories export their processed products to Japan, Italy, France, Hong Kong, Singapore, Taiwan and Korea.

David (1985) established the number of people engaged in fishing for trochus for each island in Vanuatu. The main trochus fishing islands listed in 1985 are listed below:

Table 75 Number of people engage in trochus fishing

Island	No.of Trochus Fishers	% of Fishermen
Malekula	694	34.0
Epi	223	100
Emae	177	90.0
Efate	173	17.5

No records of trochus production at the beginning of the century are available except that 60 tonnes was quoted as the trochus export figure in 1921 (Dunbar, 1981). Export statistics on production are only available since 1969.

The abundance of trochus supply during the late 1980s, resulted in the increase in number of button blank processing factories established in Port Vila and Santo. The number increase from one factory in 1986 to 5 factories in 1993. It is estimated that to produce 1.0 tons of button blanks, 10.0 tons of raw whole trochus shells is required. The table below shows exportation figures of trochus button blanks from 1986 to 1992 from Vanuatu (Amos, 1992).

Table 76 Button blank export figues (1986 – 1992)

Year	Estimated quantity of raw shells processed (tonnes)	Quantity of button blanks exported (tonnes)
1986	90.0	9.0
1987	260.0	26.0
1988	400.0	40.0
1989	780.0	78.0
1990	510.0	51.0
1991	679.0	67.9
1992	1,953.9	195.39

In 1993 a total of 5 established shell processing factories operated in Vanuatu. Prices offered for shells vary according to each factory but generally range from VT 170 to VT 300 per kg of shell. By 1996, there were only two processing factories operating. The number of established processing factories increased to 3 in 2001. In 2003 there was only one factory operating. The closure of three other factories was due to insufficient supply of raw trochus shells to process. The table below contains export figures for 1996 to 2003.

Table 77 Processing and export figures for two trochus shell processing factories (1996-2003)

Year	Raw shells processed (tons)	Button blanks exported (tons)	Trochus scraps exported (tons)	Raw shells exported (tons)	Total value (USD)
1996	263.17	26.32	57.90	No exports	US$994,970.00
1997	306.39	30.64	34.10	11.64	US$847,841.00
1998	476.43	47.64	9.420	No exports	US$700,638.47
1999	279.00	27.90	No exports	No exports	US$697,000.00
2000	286.90	28.69	42.50	No exports	US$222,895.00
2001	305.97	30.60	56.416	No exports	US$806,900.00
2002	114.00	11.40	42.35	No exports	US$260,109.00
2003	157.60	15.76	-	No exports	US$493,200.30

Listed in the table below are the 2004 export figures.

Table 78 2004 trochus export figures

Year	Commercial export item	Quantity	Measurement	Value (VT)
2004	Trochus scrapes	7,480	Kgs	867,680
	Trochus button blanks	17,250	Kgs	32,381,400
	2nd Quality shell blanks	2,900	Kgs	894,824
	Shell materials	8,000	Kgs	1,002,240
	Total	35,250		35,146,144

15.1.3 Stocks Status

Experiences in other Pacific Island countries and recent history have shown that *T. niloticus* is sensitive to intensive fishing. Though the populations may be dense, they can be severely depleted in a short period of time.

The first trochus stock survey in Vanuatu was done by L.C. Devambez in 1959 which resulted in a 4-year closure on trochus fishing (Devambez, 1959). The results of this survey indicated that:

- the average age of the trochus populations of 3 years old was high
- the proportion of young shells under 3 years old was extremely low
- the density of trochus on the reefs was noticeably low, (the average take per diver/hour was 7 trochus)

A second stock survey was conducted by the same researchers in 1961. He concluded that the stocks had increased (the average take per diver/hour was 24.1 trochus). The results of this survey persuaded the Government (*Condominium Government of the New Hebrides*) to re-open the fishery in 1962 (Devambez, 1961).

Further stock surveys were carried out in 1990, 1991 and 1992. These surveys indicate that the stocks were rapidly declining, thus tighter management controls have to be implemented to ensure the sustainability of the resource. In early 1993 the Government introduced a quota system for the established factories. Each factory is only allowed to process 75 tonnes of raw trochus shells per year. The quota system was difficult to monitor and to make sure that the quota allocated to each factory was respected. This led to factories processing more than their allocated annual quota.

Export figures show that the level of exploitation on the trochus stocks has increased tremendously as a result of the establishment of the 5 processing factories in 1993 with the highest quantity of 1,953.9 tons of raw shells being processed in 1993. This figure has since being reduced to 114 tons in 2002.

In 2004 there is only one factory operating with roughly 13 cutting machines. The closure of 4 factories and reduction of raw shell supplies could be interpreted as current stocks are not in a healthy state.

The Fisheries Department having being convinced of the poor state of the trochus wild stocks through results of random assessment surveys carried out committed itself in 1996 to an extensive trochus research project which was aimed at scientifically investigating ways to increase replenishing wild trochus stocks with hatchery reared trochus juveniles.

The Trochus Reseeding Project is funded by ACIAR and has three phases. The third phase comes to an end in 2005.

This project has been successful in preaching the importance of sustainable management and encouraging rural communities to participate responsibly in managing their marine resources, particularly the trochus niloticus resources. The implementation of the project involved restocking using hatchery reared trochus juveniles and adult trochus translocation in areas badly affected by uncontrolled exploitation by locals and very poor observation of proper management measures. Locations within the following islands were either reseeded with juvenile or adult trochus; Efate, Emae, Mataso, Makira, Nguna, Pele, Moso, Ifira, Hideaway, Malekula, Aniwa, Anietyum, and Tanna. The current status of trochus resource prior to reseeding is not very healthy, however, in 5 years time follwing restocking that is by 2010, the trochus stocks for the reseeded locations will have recovered to a very healthy state.

15.1.4 Management

Trochus resources in Vanuatu have been managed by a variety of methods. In early 1959 the Condominium Government of the New Hebrides instigated a 4 years closed season on trochus fishing. When the fishery was re-opened in 1962, a quota was enforced. The quota system was implemented as an Export quota of 75 tonnes (whole shell weight) per year for the entire country. This system ceased to operate in 1983, when a policy was introduced by the Government to prohibit the export of whole trochus shells from the country, so that the shells could be semi-processed into button blanks prior to export.

15.1.4.1 Current legislation/policy regarding exploitation

The Fisheries Regulations 17 prohibits the taking, harming, possessing, selling or purchasing of any trochus which is less than 9.00 centimeters in diameter when measured across the base. Exportation of whole trochus shell is illegal without the written permission of the Minister and it must comply with conditions he specifies.

Offences: Any person who contravenes any of the provision of this part shall be guilty of an offence and liable to a maximum fine of VT 100,000.

In early 1993 the Government introduced a quota system for the established factories. Each factory is only allowed to process 75 tonnes of raw trochus shells per year.

15.1.4.2 Recommended legislation/policy regarding exploitation

There does not seem to be adequate CPUE data to establish quotas that optimises the utilization of this resource. Discrete, separate quotas should be made for each specific and major area of exploitation. Rotational harvesting of the main areas is a possible way to exploit the fishery on a sustainable basis. Time series stock assessments are required to set realistic quotas.

The following proposed new policies have been drafted by the State Law Office particularly to control the level of exploitation of the trochus resource and should be signed and garzetted in 2004 for implementation:

Fisheries Subregulations 17(2) & (4)
"(2) A person must not take, harm, have in his or her possession, sell or purchase a trochus shell that is less that 9.0 centimeters or more than 13.0 centimeters in length".

"(4) The maximum amount of trochus that can be exported from Vanuatu in a year is 55 tonnes".

Regulation 24
Repeals the existing regulation, and is substituted with:

"24 Offences
A person who contravenes any provision of this Part is guilty of an offence and is punishable on conviction by a fine not exceeding:

(a) in the case of an individual
  (i) VT50,000 for a first offence;

(ii) VT100,000 for a second offence;
(iii) VT200,000 for a third or a subsequent offence; and

(b) in any other case
(i) VT250,000 for a first offence
(ii) VT500,000 for a second offence
(iii) VT1,000,000 for a third or subsequent offence."

15.2 GREEN SNAIL

15.2.1 The Resource

Species present:
Turbo marmoratus

15.2.1.1 Distribution

T. marmoratus is not widely distributed in the Pacific. It is exploited in only a few Pacific Island Countries including PNG and Solomon Islands. However it is widely distributed in the southward of Yakushima Island and in some southeast Asian countries such as Burma, Indonesia and the Philippines. Recently, green snail stocks are thought to have diminished in Papua New Guinea and Indonesia due to over-exploitation. In Vanuatu, *T. marmoratus* is widely distributed throughout the archipelago.

15.2.1.2 Biology and ecology

The green snail, *T. marmoratus* (family turbinidae) is the largest of the turban snails. It has a thick shell which can exceed 20.0 cm in shell width and 3 kg in total weight. The foot of the conical shell of the adult is swollen, and that of the young, round and smooth. The green snail has a massive white operculum which has a smooth inner surface.

Green snails inhabit the seaward reef slopes in shallow water down to about 15 metres. They are nocturnal in nature and feed on algae growing on dead corals and rock surfaces. The marine snails are dioecious broadcast spawners. Male and female gametes are released into the sea where fertilization takes place. A study on sexual maturity of green snails in Vanuatu made by L.C. Devambez (Devambez, 1961) in 1961 concluded that green snails reach sexual maturity at a size between 11.0 cm and 15.0 cm in diameter.

Hatchery observations on green snail spawning carried out by the Vanuatu Fisheries Research Division indicate that the snails spawn throughout the year, at night during few nights before full moon or after full moon. During the green snail spawning inductions at the Vanuatu Fisheries Department Trochus Hatchery, 5.5 million eggs were collected from a 12.0 cm size female snail. Fecundity depends on size, that is, for large green snails (greater than 12.0 cm in asal diameter) the number of eggs released can go up to 7 million eggs per female.

15.2.2 The Fishery

15.2.2.1 Utilization

Green snail shells are of great demand commercially. The shells are used mainly for decorative inlay work. The processing of green snail is very specialized. Machinery used for cutting and slicing of the shell is very technical and costly.

Green snails have been harvested by the local Ni-Vanuatu in large numbers since prehistoric times because of its tasty flesh as a source of protein, large size, and ease of capture. The snail is a vital resource for many small communities in Vanuatu. Like trochus *niloticus*, the harvesting of these snails is small but provides a significant source of revenue and employment for coastal communities. The sale of these gastropods is sometimes the only form of cash-crop available in some regions making the conservation of this resource of paramount importance.

The table below shows the level of households engaged in the collection green snails in Vanuatu.

Table 79 The number of households engaged in green snail collection

Regions	No.Households involve in harvesting of green snails	% Households involved in harvesting of green snails
Banks/Torres	326	40
Santo/Malo	316	19
Ambae/Maewo	38	4
Pentecost	225	24
Malekula	586	30
Ambrym	153	21
Paama	9	20
Epi	210	56
Shepherds	147	24
Efate	333	29
Tafea	148	9
VANUATU	**2491**	**23**

T. setosus, a member of the Turban family, is widely distributed in the archipelago and are harvested in large amounts specifically for subsistence requirements. No figures are available on the production of this species for consumption.

15.2.2.2 Production and marketing

T. marmoratus is the premium commercial shell. Current FOB price for good grade green snail cuts range from 30,000 to 35,000 USD per tonne. The major market for green snail is South Korea. The nacreous shell of green snail is a highly prized shell for inlay material of furniture lacquerware and jewellry and hence attracts a premium over all other shells in South Korea.

Green snail production in Vanuatu is small compare to trochus production. However price per kg is higher than that of trochus shells. The current price for good quality green snail shells ranges from VT 1,700 - VT 3,000 per kg.

Table 80 Export figures of green snail cuts from Vanuatu between 1986 and 2003 are shown in the following table.

Year	Green Snail cuts Export (tonnes)	Value
1986	15.00	
1987	12.00	
1988	10.00	
1989	12.00	
1990	10.00	
1991	44.00	
1992	7.35	
1993	51.03	
1994	1.07	
1995	.350	
1996	2.67	US$79,720.00
1997	3.90	US$30,000.00
1998	1.06	US$860,692.50
1999	.600	-
2000	No exports	-
2001	No exports	-
2002	No exports	-
2003	.694	US$348,000.00

Source: Fisheries Department Annual reports

15.2.3 Stocks Status

Green snail harvesting in Vanuatu for other than subsistence purposes has a long history. Green snail resources have been harvested mainly for export purposes since the beginning of the 19th century. It is a mature fishery, not a recent development like the deep bottom-fish fishery. Thus

green snail stocks within the archipelago have been influenced by long term exploitation as well as natural phenomena.

Devambez (1956) noted that during his first survey of the southern islands of Vanuatu in 1959, it took 6 divers 45 minutes to gather 11 green snails at Anelgohat reef in Aneityum island. During his second survey in 1961 at the same site, it took 2 divers 10 minutes to collect 13 green snails (Devambez, 1961).

Green snail stocks have been greatly reduced throughout Vanuatu. Assessment surveys carried out by the Fisheries Department from 1998 to 2001 all indicated that green snail stocks have been exploited to near depletion in the following islands: Efate, the Shepherds group, Epi, Santo, and Ambrym. The increased exploitation level during the early 1990s is fueled by the high commercial of the resource. The only islands which appear to have some green snail stocks are: Aneityum, Malekula and the Banks group.

This is the result of strict adherence community base management practices, which focuses mainly on resource ownership and respect for the community elders and the resource.

As can be seen from the table above, there have not been any exports of semi-processed green snail cuts since 1999. Two factors have been found to have contributed to this. First being the unavailability of the resource from the main supplying islands and second, being the observation of close seasons in the form of “TABU” placed by the community leaders to control harvesting of the resource and to allow the resource to repopulate itself.

Given the need to investigate ways to repopulate depleted reefs with green snail seeds the Fisheries Department has been allocated funds totaling VT4,000,000 in 2004 to carry out an extensive research on hatchery production of green snail juveniles and rearing the juveniles to size large enough to be reseeded to reduce predation rates. The research project is expected to be completed 2007.

15.2.4 Management

15.2.4.1 The current legislation/policy regarding exploitation

The current implemented management control that protects the green snail resources in Vanuatu is a Minimum Size Limit regulation. The legal harvesting size of green snail in Vanuatu is set at 15.00 centimeters basal length (diameter). The regulation reads:

> "No person shall harm, take, have in his possession, sell or purchase any green snail which is less than 15.00 centimeters in length when measured in its longest dimension."
>
> "No person shall export green snail except with the written permission of the Minister and in accordance with such conditions as he may specify."

Offences: Any person who contravenes any of the provision of this part shall be guilty of an offence and liable to a maximum fine of VT 100,000.

Given the scarceness of the resource throughout the archipelago, and urgent need to put in place a strict management system, the Department of Fisheries in close collaboration with the State Law Office have drafted a new regulation to repeal the above Regulation 16.

15.2.4.2 Recommended legislation/policy regarding exploitation

The Department of Fisheries must ensure that the 10 years fishing ban on green snail resources must be strictly observed. To ensure that future green snail stocks are sustainably utilized the Department must develop a management plan which should include the following:

- reference points,
- set harvest quotas per provincial area,
- set a quota on number of investors/factories
- close seasons

A new proposed management regulations has been drafted and will be refered to as Fisheries Regulation 16 which will now read:

"16 Green Snail

(1) In this regulation "green snail" means a mollusk of the species *Turbo marmoratus*

(2) Subject to subregulation (3), a person must not take, harm, have in his or her possession, sell or purchase any green snail during the period starting on 1 January 2005 and ending on July 2015.

(3) A person may take or have in his or her possession a green snail for the purpose of carrying out research or for breeding the species during the period mentioned in subregulation (2)."

15.3 GIANT CLAMS

15.3.1 The Resource

Species present

Five species of giant clams have been recorded in Vanuatu waters. These include *Tridacna maxima* (the elongated or rugose giant clam), *T. squamosa* (the scaley or fluted giant clam), *T. crocea* (the boring or crocus clam), *T. derasa* (smooth giant clam) and *Hippopus hippopus* (the horse's hoof, rolling clam, bear paw or strawberry clam). *T. gigas* (the Giant clam) was recorded by Rosewater (1965) as present in Vanuatu but recent surveys indicate the rarity or absence of the *T. gigas* species and thus its possible local extinctions.

15.3.1.1 Distribution

Giant clams, *Tridacnids*, are restricted to the Indo-Pacific region and are well adapted to tropical clear waters such as those which favour coral growth. Munro (1993) gives brief geographical distributions of each of the nine species. Due to over-exploitation or climatic changes the range of *T. gigas* has diminished a great deal. Several of the species, especially, *T. gigas*, *T. derasa* and *H. hippopus* have been introduced to some countries outside of their natural ranges.

The results of an assessment survey investigating distribution and abundance of giant clams in Vanuatu, conducted at 29 sites on 13 islands was reported by Zann and Ayling (1988). It showed that *T. maxima* is the most common species found on all islands surveyed in the archipelago. *H. hippopus* is found on almost all of the islands and most abundant on the uninhabited Cook Reef and Reef islands but absent from heavily populated areas such as Malekula. *T. crocea* was recorded only from Moso Island off Efate and Sakau Island near Malekula. The distribution of *T. squamosa* is obscure as only dead shells were recorded on only 2 islands, Aneityum and Cook Reef, during the 1988 survey and five live clams were recorded in the Malekula group during the detailed survey of the area. However, it could be on more islands as it was possible they had been included in the *T. maxima* counts. Both *T. gigas* and *T. derasa* have not been recorded on any island recently. However, Fisheries personnel indicated that the smooth clam (possibly *T. derasa*) were seen being offered for sale at the Vila public market. This was on very rare occasion and the possible source could have been the Moso or Lelepa Islands.

15.3.1.2 Biology and ecology

The giant clam family, Tridacnidae, currently has nine living species in two genera, *Tridacna* (Bruguiere) and *Hippopus* (Lamarck) and include the largest bivalve molluscs known. A unique characteristic of the giant clams is their symbiotic relationship with dinoflagellate algae, zooxanthellae, which live in the blood system of the giant clams concentrating in the tissues of the brightly-coloured mantle that is exposed to light in the shallow sunlit waters of coral reefs (Munro, undated). (Giant clams acquire the symbiotic algae at age 7-15 days). They receive photosynthetic sugars and oxygen from the algae while the algae receives waste carbon dioxide and nutrient salt from the clams. In addition, giant clams also filter feed as is typical of other bivalves but all of its maintenance requirements can be derived from the symbiotic algae (Munro, 1993). The zooxanthellae restrict clams to shallow waters.

All species of giant clams mature initially as males (protandrous hermaphrodites) at the age of two or more years, depending on the species, and eventually become simultaneous hermaphrodites. Reproduction in the central tropics does not seem to show seasonality. However, seasonality is shown in gonad ripening at the northern and southern limits of distribution (Munro, 1993). Some degree of lunar periodicity has been observed. During spawning, sperm are normally released first followed by egg release after a short interval (generally ~30 minutes). Fecundity of *T. maxima* was estimated by Jameson (1974), and Munro (1993) reported that a 20 cm specimen with ripe gonads would contain 20 million eggs. Eggs produced from 70-80 cm *T. gigas* were known to produce up to 240 million eggs. Fertilized eggs develop into swimming trochophores within 12 hours and shelled veligers within 36 hours. The larval phase duration lasts between 5 and 15 days after

which it settles on the bottom. Soon after this it metamorphoses into a juvenile clam. Recruitment is low and erratic. Growth parameters for most of the giant clam species in several localities are given in Munro (1993). Overall, for the first few years, growth rates range between 3.5 to 10 cm per year depending on species. Natural mortality is low.

15.3.2 The Fishery

15.3.2.1 Utilization

Dalzell (1990) noted that giant clams are an esteemed food item for ni-Vanuatu who consumed an average of 19.1 kg of shellfish/capita/yr, making them an important component of sea-food consumption in the subsistence sector. The supply of giant clams to the public market in Vila has mainly been from north Efate, i.e. Moso and Lelepa Islands. On most of the islands, giant clams are collected as a subsistence food item. Shells of giant clams, mostly *H. hippopus* are often offered for sale in Port Vila streets.

It was until 1998 that the gaint clams became a luxcrative commodity in the aquarium trade business. Species highly sort are *T. maxima* and *T. crocea.* This is because of their very colourful mantles. From 1998 to 2000 large quantities of *T. maxima* and *T. crocea* were harvested from north Efate, particularly from Moso and Lelepa islands by the locals and sold to the aquarium traders based on Port Vila.

15.3.2.2 Production and marketing

No figures are available but the total annual estimated subsistence harvest in 1983 of 2,403t consisted of 33.5%, by weight, of shellfish comprising of oysters, clams and cockle families (David, 1985). Relative compositions of the three families were not given. Only on rare occasions are giant clams seen offered for sale in the public market in Vila. This is mostly on Saturdays and the species involved are *H. hippopus, T. squamosa* and sometimes *T. maxima* which are sold in baskets. Estimates of landings and revenue from the sales of shells are not known.

Summarized in the table below are number of clams harvested from north Efate and from the surrounding off-shore islands, that is, Lelepa, Moso, Pele, and Nguna mainly for the aquarium trade exports. 90% of total giant clams exported are of the species *T.crocea*.

Table 81 Total Giant clams exports from Vanuatu (1997 – 2003)

Year	Giant Clams
1997	350
1998	16160
1999	11835
2000	26746
2001	13496
2002	4057
2003	2000

15.3.3 Stocks Status

T. gigas and *T. derasa* are believed to have become locally extinct since recent surveys did not find any specimen, even though Vanuatu was included in the distribution of these species by Rosewater (1965). However, on rare occasions Fisheries Officers have recorded smooth-shelled clams (*T. derasa*) been sold in the public municipal market. This may be an indication that small populations of the smooth-shelled clams still exist but only in some islands mainly the Moso and Lelepa islands. *T. gigas* fossils were reported by Munro (quoted in Zann and Ayling, 1988) from Efate. Zann and Ayling (1988, and 1990) provided the following tables on the distribution and abundance of the giant clam stocks for species found in Vanuatu at sites on which rapid surveys were conducted in 1988. The areas covered were the reef slopes (< 10 m depths) and lagoon reef patches using spot dives and manta tows.

Table 82 Summarized results of the 1988 giant clam survey

	Abundance (numbers per hectare)			
Location	***T. maxima***	***T. squamosa***	***T. crocea***	***H. hippopus***
Aneityum				
Port Aneityum	16	shells only	-	-
Inyeug Island	50	-	-	shells only
Port Patrick	16	-	-	-
Tanna				
Leviar	5	-	-	-
Port Resolution	-	-	-	-
Erromango				
Dillon's Bay	shells only	-	-	-
Efate				
Lelepa	3	-	-	-
Malao Bay	-	-	-	shells only
Moso Island	7	-	3	3
Cook's Reef	10	shells only	-	25
Pentecost				
Wanuru	6	-	-	9
Loltong Bay	20	-	-	-
Gaua				
Lesalau Bay	9	-	-	1
Ureparapara	shells only	-	-	-
Reef Islands	13	-	-	23
Epiritu Santo				
Big Bay	-	-	-	-
Hog Harbour	2	-	-	2
Turtle Bay	-	-	-	-

A detailed survey, using replicate belt transects, at selected locations in the Malekula Group was presented by the same authors as reproduced in the following table. No clams were found on the reef flats.

Table 83 Summarized results of the Malekula group survey

	Abundance (numbers per hectares)							
	Reef Crest				Reef slope			
	T.m.	**T.s**	**T.c**	**H.h.**	**T.m.**	**T.s**	**T.c**	**H.h.**
Maskelynes								
Matai/SE:exp	24	-	-	-	8	8	-	-
Sakau/SE:exp	32	-	-	-	16	8	-	-
Sakau/S:m. exp	-	-	-	-	8	8	-	-
Sakau/NW:shel	-	-	48	-	-	-	-	-
Cook Bay:v. shel	-	-	8	-	24	8	-	-
Atchin Island								
SE:exp	-	-	-	-	16	-	-	-
Malakula								
Port Sandwich								
E:exp	8	-	-	-	8	-	-	-
E:exp	-	-	-	-	-	8	-	-

T. maxima is the only species that was recorded in all of the islands surveyed. Even though *H. hippopus* was not found on all of the islands, significant populations exist in uninhabited areas, Cook reef and Reef Island. However, this species was not found in the detailed survey in the Malekula Group which is more heavily populated. *T. crocea* is rare and was recorded only at

Moso Island and off Sakau Island near Malekula. However, its abundance at Sakau/NW was high. Live *T. squamosa* were only located at five sites in Malekula with low abundance.

Recent stock assessment surveys by the Department of Fisheries from 1998 – 2000 were conducted on 57 sites on the islands of Anietyum, Erromango, Tanna, Efate, Emae, Mataso, Makira, Malekula, Gaua, Vanua Lava, Mota Lava, Ureparapara and Torres island. Average density of all giant clams calculated as numbers per 100 m^2 was generally low in all the survey sites, as can be seen on the table below. Slightly high population was recorded in the Banks group sites, which is expected as the fishing pressure is relatively low. Analyses of the survey results indicated that a very low density of giant clams exist through out the country's reefs. In the Shepherd islands sites the average density of all clams in the sampled areas was less than 1 clam per 100 m^2, 1.5 clams per 100 m^2 for sample sites in TAFEA province, 3 clams per 100 m^2 for TORBA province and 1.3 clams per 100 m^2 for the sites in MALAMPA province.

Table 84 Number of giant clams per sampled area

Survey Location	**Abundance**							
	Reef crest/Lagoon				**Reef slope**			
	Tm	**Tsq**	**Tc**	**Hh**	**Tm**	**Tsq**	**Tc**	**Hh**
Gaua - Losolava	6	1	0	1	5	0	0	3
Vanua Lava – Vureas Bay	0	0	0	0	44	0	0	0
Pakea Island	0	0	0	0	31	1	0	0
Ravenga -West	0	0	0	0	41	0	0	2
- North	0	0	0	2	66	1	0	2
Mota Lava -Ra	0	0	0	0	20	0	0	0
Reef island – N.West	0	0	0	0	178	8	0	0
-West	4	0	0	0	126	0	0	2
Ureparapara-Lagoon	0	0	0	0	97	0	0	2
Hiu-Picot Bay	0	0	0	0	153	0	0	0
Metoma	0	0	0	0	0	1	0	0
Tegua-South	0	0	0	0	19	1	0	2
Loh	0	0	0	0	7	0	0	0
Malekula -Sakau	7	3	7	3	0	0	0	0
- Lamap	71	5	4	2	0	0	0	0
- Uri	19	3	0	1	0	0	0	0
- Tedka	37	17	5	2	0	0	0	0
- Pinalum	27	4	0	0	0	0	0	0
- Vao	26	14	3	0	0	0	0	0
- Port Stanley	0	3	6	0	0	0	0	0
- Litz Litz	16	12	4	0	0	0	0	0
- Lambubu	37	14	0	0	0	0	0	0
- Crab Bay	1	1	0	0	0	0	0	0
- Avok	25	7	0	2	0	0	0	0
Emae - Marae	0	0	0	0	80	5	0	0
- Sulua	0	1	0	1	100	2	0	1
- Worarana	1	0	0	0	0	0	0	0
- Makatea	1	0	0	0	0	0	0	0
- Siwo	8	2	0	2	0	0	0	0
- Vaitini	0	0	0	0	24	6	0	0
Cooks Reef – West Lagoon	14	6	0	2	0	0	0	0
- North Flat	1	0	0	4	0	0	0	0
Makira	1	0	0	0	1	0	0	0
Mataso-Na'asang	1	1	0	0	0	0	0	0
-South	0	0	0	0	10	1	0	0
Mistery Island –East reef flat	65	25	0	1	0	0	0	0
-North lagoon	0	0	0	0	15	0	0	0
Aneityum – Anelgouhat-east	0	0	0	0	102	5	0	0
-Port Patrick-central	19	0	0	0	0	0	0	0
Port Patrick-south	15	2	0	0	0	0	0	0
Tanna-Port resolution-east	10	0	0	0	0	0	0	0

Survey results *indicated that the most abundant giant clam species is Tridacna maxima, followed by Tridacna* squamosa. *Tricdacna crocea* and *Hippopus hippopus* population appears to fished out in all surveyed locations.

Significant population of *T.maxima* was observed an Anelgouhat reef on Aneityum island, Dillons Bay reef on Erromango island, Vao and Labubu on Malekula, Cooks Reef on Emae, and Reef island in the Banks group. *T. crocea* was observed in abundance at Moso reef (Tassiriki side to Tranquility Reserve area), also on Lelepa island and Ifira and Malapoa Point areas. The survey observed a significant population of *T. crocea* on giant clam reserve area owned by Tranquility island Resort on Moso Island.

H.hippopus stock has been heavily fished in all the coastal reefs except on remote reefs and small community protected giant clam gardens. The survey figures clearly indicated the scarcity of this particular clam species in the country. Stock assessment survey is an ongoing activity for the Fisheries Department.

15.3.4 Management

Over-exploitation leading to local extinction has been well documented for giant clams. However, the effect of this on the giant clam populations in Vanuatu is not known.

Some shells of giant clams offered for sale in the Port Vila streets are far too small as far as conservation of stocks is concerned. It was not possible to confirm whether these shells have any bearing on the sizes harvested for consumption or whether those particular shells were dead when found.

15.3.4.1 Current legislation/policy regarding exploitation:

There is currently no legislation in force for the management of giant clams in Vanuatu. However, PART II Sections (20) subsection (1) and (2) of the Fisheries Act CAP 158, provides the authority to the Minister responsible for Fisheries Sector to declare an area within Vanuatu waters to be a Marine Reserve. A marine reserve has been established at Crab Bay in Malekula. The area has giant clams, mostly *H. hippopus.*

In 2000 the Government passed a Policy to ban harvesting of wild giant clams on Efate and neighbouring islands for purposes of the aquarium trade exports. *T. crocea* is banned for aquarium exports. The ban also prohibits the harvests of *T. maxima* on Efate island. However, it can still be harvested from the off-shore islands and shipped into to Port Vila for the aquarium exports.

15.3.4.2 Recommended legislation/policy regarding exploitation:

Application of minimum size limits has been employed as a management tool for giant clam stocks in several countries. This is especially beneficial when giant clams have low natural mortality and thus "the largest yields will be obtained by taking giant clams at relatively large sizes" (Munro, 1993). Munro further noted that a combination of minimum size limits and the imposition of annual quotas to be harvested in a single short season offer the best prospects.

Even though the establishment of reserves has not been proven to increase recruitment in depleted areas, it would at least play a role in conserving the genetic pool of the remaining stocks. The rapid and successful progress in giant clam mariculture offers the possibility of augmenting or re-seeding depleted areas using hatchery-reared juvenile clams.

The following recommendations should be considered:

- The Government of Vanuatu to accord special protection to uninhabited Cook's reef and Reef Islands, where *H. hippopus* are common.
- The Government of Vanuatu to reintroduce *T. gigas* and restock *H. hippopus*.
- Introduce size limitations for all species of giant clams in Vanuatu

The low levels of *T. squamosa* recorded would also single out this species as needing restocking. Fairbairn (1992) concludes that prospects exist in Vanuatu for the establishment of giant clam

mariculture projects, especially in certain areas on Santo, Efate, and Malekula. A project of this nature would, however, require the support of the village council and chiefs, and the landowners concerned.

Establishment of a small-scale giant clam hatchery for re-seeding purposes of the native species would seem feasible. Facility costs will be minimal as the existing hatchery for trochus/green snail can be used.

15.4 OYSTERS

15.4.1 The Resource

Species present
Endemic species include, *Saccostrea glomerata* (formerly *Crassostrea glomerata*) and *Crassostrea echinata*. *C. gigas* was introduced in the 1920's.

15.4.1.1 Distribution

With the exception of the Arctic and Antarctic regions, oysters are found in all the sea areas of the world.

Species of oysters vary widely, from those living on the rocky reefs of outer ocean coasts with high salinity waters to those living in the inner recesses of bays with a high degree of fresh water flow. Approximately 200 species of oyster are known to exist in the world, and of these about 25 are believed to live in the waters of Japan (Yamaha, 1989).

Very little is known about the distribution of native oyster species in the Vanuatu waters, except for oysters found near Turtle Bay (Santo), Oyster Island (Santo) which, are of the introduced species from Australia in 1920. Oysters are found in Port Sandwich (Malekula), Port Havannah (Efate), also north of Port Havannah Bay, and the inner lagoon at Erakor (Efate).

15.4.1.2 Biology and ecology

Among the varieties of shellfish presently inhabiting the earth, the most prolific are the conch (Gastropoda) and bivalve (Pelecypoda) families. Of the conches, about 85,000 species exist while the Pelecypoda family has about 25,000 species. The conches actively search for food on the ocean floor with eyes and feelers, the bivalves such as scallops tend to bury themselves in the ocean floor or, in the case of oysters, attach themselves to rock outcroppings or reefs.

The soft body of the bivalves is fully enclosed in a shell and a mantle with which the shell is, so to speak, lined. There is also a gill between the mantle and internal organs. On the back edge of the body are a number of water pores through which water is drawn in to pass through the gill and thus constitute the breathing function. At the same time, the gill also functions to separate debris in the water from edible suspended matter such as plankton for the ingestive process. The volume of water thus processed by the gill in the case of "Magaki" (Pacific cupped oyster) is said to be about 10 litres per hour. Virginia oyster (American cupped oyster) filters about 5-25 litres/hour at a water temperature of 20 C°. This means that some oysters process more than 1000 times their body weight (without shell) of water every hour (Yamaha, 1989). The amount of vegetable planktons consumed by an adult oyster in one day is thought to be between 1 and 5 grams.

Within the same species of oyster there are considerable differences in the shape of the shell and other biological characteristics depending on the environment conditions within they live.

The number of eggs produced by a single mature oyster ranges from 50 to 100 million (Yamaha, 1989). Fertilized eggs and larvae begin a random process of dispersion and reconcentration in accordance with the whims of forces like tides, wave motion and eddying currents. After two or three weeks in this drifting phase they enter the fixed stage of their life cycle in which they attach themselves to some stationary object. Oysters feed primarily on vegetable planktons and detritus, but the amount of food consumed varies with species and also in accordance with the stage of growth and life environment conditions.

Shell growth is greatly influenced by such factors as water temperature and salinity, currents and gestation. It is generally most active in the spring and autumn, and tends to stagnate in the spawning season of summer and in winter.

15.4.2 The Fishery

15.4.2.1 Utilization

Oyster culture has been practised since ancient times. The fine taste of the oyster meat itself must have prompted man to attempt the deliberate production of oysters. The estimated annual worldwide harvest of oysters is around one million tons (weight including shell), most of which is the product of artificial proliferation and culture fisheries (Yamaha, 1989). The principal species include the Pacific cupped oyster (*C. gigas*), American cupped oyster (*C. virginica*), European flat oyster (*Ostrea edulis*) and Portuguese cupped oyster (*C. angulata*).

Like many other South Pacific island countries, oyster farming on a trial basis had been attempted in Vanuatu during the 1970's. The farming trial was not successful. At present, oyster is mainly utilised for subsistence consumption with a small portion marketed locally. The Masklyne Islands appear to be main supplier of Mangroove Oysters for the Port Vila market.

15.4.2.2 Production and marketing

The main oyster producing nations are Japan, Korea, Mexico, France, and the U.S.A. Among these the U.S.A., Japan and Korea are the major producers, each counting for between 23 and 26% of the total world production (Yamaha, 1989).

Production of oysters in Vanuatu is very small and no records exist even for the portion that is marketed locally.

Oyster culture experiments were initiated in Vanuatu in 1972. Van Pel (1956) suggested that the Philippine method of rack culture be employed. Suitable culture locations included the shallow sheltered waters of southeast Santo, southeast Malekula, in the northern lagoon of Port Vila, in the inner lagoon at Erakor, and in Port Resolution (Tanna). The protected waters in Port Sandwich was suggested as a good place for the initials trials.

The rationale for oyster culture in Vanuatu included meeting local demand and exporting surplus production (Hallier, 1977). *C. gigas* was selected for culture, in preference to the two local species for the following reasons:

- *C. gigas* is virtually the sole species existing in the South Pacific for which large supplies of spat are easily available;
- this avoids the difficulties attending the collection of native spat, a tricky matter since local stocks are never very large and little is known about their spawning period;
- *C. gigas*, a fast growing species, is very similar in appearance and taste to *C. angulata* and therefore likely to go down well with European consumers in Vanuatu and in New Caledonia (Hallier 1977).

Oyster culture experiments were conducted at the following locations:

- the Mounparap Oyster Breeding Station on the island of Santo,
- Lamap in Port Sandwich Bay farm in Malekula island, and
- the island of Efate (Erakor lagoon).

In October of 1972, 20,000 unattached spat of *C. gigas* from the hatchery of W. Budge Mariculture Farm, Pescadero, California, were planted in Mounparap Bay (Santo). During 1973, batches of 100,000 spat came in approximately every six weeks. About 600,000 *C. gigas* spat were grown in the Santo farm. This farm materialised through an association of private interests (Autrand, 1973). The venture received financial assistance from the New Hebrides Condominium in the form of

long-term credit and the experiment was conducted for over a period of two years. Spats of the native rock oyster, *C. echinata*, was also collected and farmed by a private oyster farm (Doumenge, 1973).

The Port Sandwich Oyster farm was set up in April, 1973. This venture was formed by 165 islanders from five villages in the area and the operation was financed by the French Administration. 100,000 *C. gigas* seeds were imported from the same California hatchery. Continuous trials were conducted for over a period of one year. Growth rates recorded were comparable to those obtained at the Santo operation.

Results from these experiments were disappointing and the breeding of *C. gigas* in Vanuatu had to be discontinued without any definite conclusions been reached. The harmful action of the parasites, *Polydora*, and especially *Pseudostylochus*[6], were observed. High mortality rates and poor growth were observed during the hot season, which was also the period of highest rainfall.

However, a private oyster farm set in Santo in 1972 had better results. Production was 4,000 dozen per month, which was marketed in Luganville and Vila. However, the two most significant problems that remained were irregular supplies of spat and the control of the predator, *Pseudostylochus*.

15.4.3 Stocks Status

There are no consistent records of the current stocks of oysters in the Vanuatu waters and there have not been any surveys done on the very small existing stocks.

Van Pel (1956), based on his observations reported that oysters appear to be plentiful in Vanuatu. However this is not the case at present and only limited areas would adequately support oyster growth. The only area that has substantial stocks of Oysters would be the Oyster Island Resort in Santo.

15.4.4 Management

15.4.4.1 Current legislation/policy regarding exploitation

There is no legislation currently in force that deals with this resource.

15.4.4.2 Recommended legislation/policy regarding exploitation

None seems to be required. However, consideration could be given to the introduction of exotic species into Vanuatu to farm for consumption at the local markets. Current imported New Zealand Oyster is sold at VT3,000 per half a kilogram.

[6]Pseudostylochus is a flat worm measuring less than 1.00 mm in thickness and reaching a maximum length of 5.0 to 6.0 cm. Its shape varies and it is capable of moving in all direction, in much the same way as an amoeba. It lives in darkness and is highly sensitive to fresh water.

15.5 ORNAMENTAL (SPECIMEN) SHELLS

15.5.1 The Resource

Species present
Numerous species of shells are offered for sale to tourists. They include cones, cowries, helmet, trumpet, triton, spider, giant clams, nautilus, black-lipped pearl oyster (*Pinctada margaritifera*), etc. Lewis (1985) notes that collector's shells are marine invertebrates from the classes Gastropoda (sea shells), Pelecypoda (bivalves), Scaphopoda (tusk shells) and Cephalopoda (nautilus).

Wright (1989), reports that the Melanesia Shell Produts Ltd (MSP) was involved in the trade of certain shells including the giant triton, *Charonia tritonis* both locally and overseas. There is currently no information on lists species found in Vanuatu.

15.5.1.1 Distribution

Most shellfish are habitat specific but are found in every type of marine habitat, from coral reefs and sand to silt and mud (Smith, 1992). They occur throughout the world but the centre of distribution and maximum diversity is generally considered to be the area of ocean bordered by Indonesia, Papua New Guinea and the Philippines. Currently there is no information on the distribution of *P. margaritifera* in Vanuatu.

15.5.1.2 Biology and ecology

C. tritonis shell can reach 40 cm or more in length and is usually found among corals on coral reefs and feeds mainly on starfish, including *Culcita novaeguinea*, the blue starfish *Linckia laevigata* and the Crown-of-thorns, *Acanthaster planci*, but also occasionally on holothurians (Wells *et al*, 1983). Maximum size is attained in up to six years and female lays clumps of sausage-shaped egg capsules under protective rocks. Larvae are long-lived and have considerable dispersal abilities. The biology and ecology of *P. margaritifera* is well documented for other countries.

15.5.2 The Fishery

15.5.2.1 Utilization

Kay and Smalley (1989, quoted in Smith, 1992) categorises shells into five groups in the shell trade. These are ornamental shells (e.g. cones and cowries); shells used in shell craft (e.g. money cowries and helmet shells); specimen and rare shells (e.g. golden cowry); commercial shell (e.g. trochus, pearl oyster); and shells used for food. The shell trade in Vanuatu, is mainly for the tourists and include shells of those collected for food (e.g. giant clams) as well as the shells collected solely for sale (e.g. cowries and cones). No specific fishery is based on *P. margaritifera* except that its use is limited to the sales of the shells in the local ornamental trade.

Shell collecting is mainly done by walking over areas of sand in lagoons or coral at low tide. They are sometimes found under rocks or by searching through areas of sand (Lewis, 1985). Fishing for shellfish species in deeper water require diving and these are sometimes picked up during spearfishing operation.

15.5.2.2 Production and marketing

The Fisheries Department does not currently collect any data on this fishery nor have there been any attempt to estimate shells that are sold on the streets in Vila. However, the Department of Fisheries issues souvenir permits to tourists or shell collectors on an adhoc bases when it is requested. The quantity of shells taken out of the country as souvenirs is very small.

15.5.3 Stocks Status

Information on stocks of the species involved is non-existent. Stock status information for giant clams is discussed in this Profile. A note here though is that *H. hippopus* shells seen being offered for sale in Vila consist mostly of shells that were about 3-4 inches in length. It is not clear whether this size is targeted for this species for the trade or it is a reflection of the size collected for home consumption. *C. tritonis* is listed as rare in the IUCN Invertebrate Red Data Book.

15.5.4 Management

15.5.4.1 Current legislation/policy regarding exploitation

The only regulation that covers any species in this category is that for trumpet shell, Fisheries Regulation 18. Under the regulation, trumpet shell is defined as *C. tritonis* and the taking, possessing, selling or purchasing of a shell of this species less than 20 cm in length is prohibited.

Penalty is a fine of not more than VT100,000 for any offences.

15.5.4.2 Recommended legislation/policy regarding exploitation:

Recommendations in other countries concerning ornamental shells trade include banning direct export, harvesting areas restriction and annual rotation, use of SCUBA or dredging. Because of the apparent detrimental effect of collection on *C. tritonis* populations in many countries, collection and export have been banned, e.g. in Fiji (Wells *et al*, 1983). The Fisheries Department should consider enacting a policy to ban harvests or collection of *C. tritonis*.

15.6 OTHER BIVALVES

15.6.1 The Resource

Species present
Clam (*Anadara sp*), cockles (*Gafrarium* sp) and mussels (*Modiolus* and *Brachiodontes*).

15.6.1.1 Distribution
These bivalve species are mostly associated with areas where mangroves thrive and thus their distribution is limited to these areas.

In Vanuatu, the bivalves species can only be found in certain islands such as Malekula, Emae, Efate, Banks group, Santo, particularly islands where there are managrove populations.

15.6.1.2 Biology and ecology
The biology of the locally found species as included in this section has not been studied. Cockles commonly inhabit muddy seashore and burrow only into the surface of the mud. Farmed cockles, *Anadara granosa*, in Thailand are harvested after 18 months when they reach about 4 cm and 24 g in weight (Tookwinas, 1983). In India the same species is found to spawn throughout the year and can have 2-4 reproductive cycles in a year. First maturity is attained at 20 and 24 mm for males and females respectively (Narasimham, 1988).

15.6.2 The Fishery

15.6.2.1 Utilization
Fisheries based on these species are mainly for home consumption (subsistence) in areas where they are found. Collections are done both by men and women. Main collection area on Efate island is the Erakor Lagoon. However, with the change to cash economy, some of the catches are being sold, e.g *Anadara*, but at very low levels. Shells are also sold to the tourists as ornaments. The native mussel species are utilized on the subsistence level only. *A. granosa* has been successfully farmed in Asia.

15.6.2.2 Production and marketing
No estimates are available on the production from these species either at the subsistence or artisanal level, even for the areas where they form an important component of the reef catch. David (1985) estimated the total village fishing production to be approximately 2,402 tonnes of which 33.5% (about 810 tonnes) consists of bivalve mollusc (clams, cockles and oyster family).

15.6.3 Stocks Status

Stocks status of the native species is unknown.

15.6.4 Management

Because of the limited level of utilization and their low level in importance as commercial species, management has not been considered.

15.6.4.1 Current legislation/policy regarding exploitation:
No legislation exists concerning the exploitation of species in this section.

15.6.4.1 Recommended legislation/policy regarding exploitation:

Given the increase collection pressure on the cockle stocks in the Erakor Lagoon by locals for both subsistence and as a source of income, the Department of Fisheries should consider carrying out an assessment stock survey of the lagoon to determine the stock status of the cockles and consider placing a ban for up to 3 years on collection of the resource.

15.7 OCTOPUSES & SQUIDS

15.7.1 The Resource

Species present

Octopus production is mentioned in only one reference located during the review. It does not however identify the species found within Vanuatu. Smith (1992, notes that the common octopus, *Octopus cyaneus*, is widespread in the Indo-Pacific region. There is no squid fishery known in Vanuatu.

15.7.1.1 Distribution

Octopuses generally "hide" in small holes in reefs and are found both intertidally and subtidally around reefs and rocky areas. Distribution of octopuses is wide spread through all islands of Vanuatu.

15.7.1.2 Biology and ecology

As in all cephalopods, sexes in octopuses are separate and prior to mating there is often an elaborate mating ritual involving colour changes and touching of tentacles. One of the male's tentacles is modified to carry sperm to the mantle cavity of the female and eggs are usually brooded and they develop directly into tiny adult form (Smith, 1992). They actively predate on crustaceans and mollusc and are usually solitary.

15.7.2 The Fishery

15.7.2.1 Utilization

Traditionally, octopus fishing involves the use of a cowry decorated to look like a rat. This is also practised in some Polynesian communities. David (1985) reported that "octopus fishing is only conducted to the south and east of a line between Malo, Ambae and Ambrym" and that the number of households fishing cephalopods is closely correlated with the total number of fishermen surveyed. Half the cephalopod fishermen are concentrated on Malekula and Efate. The household survey on Malekula, Paama, Epi, Nguna/Pele, Efate and Tanna, indicated that only 9.5% of the octopus fishermen sell part of their catch. In Tanna, the octopus fishermen sold 77.5% of their catch. Details are given in the following table as was given by David (1985). The figures are those per week and represent 9.5% of the total landing as estimated by the same author.

Table 85 Number of Fishermen/Fisherwomen per island

	OCTOPUS SOLD			**FISHERMEN SELLING THEIR CATCH**		
Island	Number	Geographical distribution (%)	% of catch	Average sales per house-hold	% of fishermen	Geographical distribution (%)
Tanna	31	40.8	77.5	15.5	100	16.7
Malekula	15	19.8	8.0	5.0	6.0	25.0
Efate	13	17.1	19.3	4.5	13.5	16.7
Nguna-Pele	8	10.5	20.5	4.0	40.0	16.7
Epi	7	9.2	24.0	3.5	22.0	16.7
Paama	2	2.6	14.5	22.0	25.0	8.0
Vanuatu	**76**	**100**	**15.5**	**6.5**	**9.5**	**100**

Catching is mostly done using spear guns but at low tide, the fishermen simply walk over the reef and poke into the holes, suspected to "house" an octopus, using a rod.

15.7.2.2 Production and marketing

Of the total extrapolated annual fisheries village production of 2,402t in Vanuatu in 1983, 3.0% (66 t) accounted for octopuses of which 15% (10.5t), worth VAT 1.5 m, was sold (David and Cillaurren, 1989). Data obtained by the Fisheries Department from Natai Fish Market, Santofish and the Fisheries Extension Centres in the outer islands indicate that there was no local production of octopus going through these outlets.

There is however a possibility that octopus could be lumped under the "other" category due to minimal amounts. Otherwise octopus has been completely utilized on the subsistence level only. Fresh "baby octopus", imported from New Zealand were being sold at the Natai Fish Market during July 1993 at VT 1,390 per kg.

Recent data production of octopus is nonexistent even though the resource is still harvested for subsistence use and also sold at the Port Vila Urban markets.

15.7.3 Stocks Status

Stocks are not known as no study has been conducted nor data collected for this particular resource.

15.7.4 Management

There does not currently seem to be any commercial demand for octopus in Vanuatu and thus exploitation is limited to subsistence. A possible threat to the resource would be the destruction of habitat (reefs).

15.7.4.1 Current legislation/policy regarding exploitation

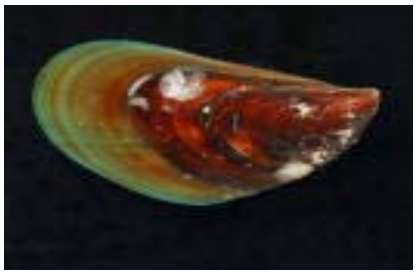
No legislation exists regarding the exploitation of octopus in the Republic.

15.7.4.2 Recommended legislation/policy regarding exploitation

It appears that there is currently no problem with the commercial exploitation of the resource. However, exploitation for subsistence purposes needs monitoring and some form of management control by the Fisheries Department.

16 SPECIES WITH POTENTIAL FOR INTRODUCTION FOR AQUACULTURE

16.1 The Resource



Species
The green mussel, *Perna viridis*.

16.1.1 Distribution

No green mussel species exist in Vanuatu.
Two green mussel species, *P. viridis* and *P. canaliculus*, are being cultured commercially in some countries. *P. canaliculus*, the green-lipped mussel, is restricted to the temperate waters around New Zealand, whereas *P. viridis*, the Philippine green mussel, occurs widely in tropical waters throughout the Indo-Pacific region from the Persian Gulf to southern Japan and through Malaysia, Indonesia and the Philippines (Siddall, 1980). A closely related brown mussel *P. perna* is found around the African continent and in the northern half of South America (Hickman 1989).

The green mussel is not endemic in the tropical islands of the Pacific (Hickman, 1989). It has been introduced to several countries specifically for aquaculture purposes. *P. viridis* from the Philippines were introduced into New Caledonia in 1972, Fiji in 1975, Tonga in 1978 (Hickman, 1989) and from Tahiti to Western Samoa in 1982 (Bell and Albert, 1983). Mussels were transferred from New Caledonia to French Polynesia in 1978 for the development of larval rearing techniques (Uwate, *et al*, 1984).

Any attempt to farm the Philippine green mussel farming in Vanuatu would involve a species introduction. There have not been any introductions of green mussel into Vanuatu. As for the native mussel species, little is known about their distribution within the Republic.

16.1.2 Biology and ecology

The Philippine green mussel, *P. viridis,* inhabits estuarine or coastal waters that are rich in plankton, warm (26-32 Degree Celcius) and of high salinity (27-33ppt). Mussels can tolerate short periods of exposure to extremes of temperatures and salinity, and to high turbidity from suspended sediments.

Spawners release their eggs and sperm into the water where fertilization takes place. Fertilized eggs hatch into free-swimming larvae within 24 hours. They remain in this stage for 15-20 days, after which they are ready to settle and attach themselves to solid substrates (Valmayor, 1977). A firm substrate is required for larval settlement and for subsequent byssal attachment throughout juvenile and adult life. There must be adequate flow of current to provide sufficient food for growth, prevent build up of faecal and pseudofaecal material, and to disperse the larvae during their 3-4 weeks free-swimming phase.

Mussels are subject to predation by starfish, crustaceans and fish throughout their life span and possibly also to carnivorous molluscs and annelids as spat and juveniles. There have been few reported parasites and diseases of green mussels.

Mussels are filter feeders. They feed predominantly on phytoplankton but with some intake of detrital suspended matter. High levels of inorganic suspended matter reduce the mussel's feeding ability by "diluting" the amount of nutritionally useful material it is able to filter (Hickman 1989). As filter feeders, mussels are vulnerable to organic and chemical pollution and to natural phytoplankton blooms such as red tides.

The male mussel can be distinguished from the female by the colour of the meat. The meat or mantle of a male mussel is generally milky white to creamy, while that of a mature female is orange to red. Sexual maturity in *P. viridis* is attained at 20-30 mm in shell length (3-4 months old).

16.1.3 The Fishery

16.1.3.1 Utilization

Mussel is a food item that could help meet the nation's need for a low-cost, high-quality protein food. Its wholesome taste plus its importance in nutrition makes it a speciality in hotels and first-class restaurants. Commercial cropping of mussels is common in those countries where the mussels are farmed, while subsistence cropping of mussels is common in those countries where the mussels occur naturally.

Native mussel species are only utilized on a subsistence level in Vanuatu, mainly as a source of protein.

16.1.3.2 Production and marketing

Mussels are farmed extensively throughout the world. Spain, China, Holland, and Denmark each have an annual production of about 100,000 tonnes (Hickman, 1989). The vast majority of the world's annual production of 800,000 tonnes comes from the farming of blue mussels, *Mytilus edulis* and *M. galloprovincialis* with only 10% being derived from the green mussels *P. viridis* and *P. canaliculus* (FAO, 1988a).

Green mussels are farmed commercially in Thailand, the Philippines and New Zealand. New Zealand is the only country that exports significant quantities of green mussels (FAO, 1988b).

The native mussel stocks, if any, are not sufficient to meet the local demands. Vanuatu imports small quantities of New Zealand green-lipped mussels mainly for the restaurant and hotel market in Port Vila.

16.1.3.3 Potential Sites

The Vanuatu Fisheries Department has received expressions of interest in pursuing the possibilities of green mussel farming. Mussel farming is seen to have a potential for import substitution. The small size established market of green mussels in Vanuatu and the dubious sanitary quality of the potential mussel farming areas close to Port Vila, suggest that the development of mussel culture based on the established market is viable.

In 1989, Robert W. Hickman, FAO Consultant, carried out a case study in Port Vila, Vanuatu on the potential of farming green mussels in Vanuatu. Hickman surveyed two lagoons, the Erakor and Eratap Lagoons which are the only sites close to Port Vila considered by the Fisheries Department to have mussel aquaculture potential.

The survey results indicated that Erakor Lagoon has perhaps 120 ha of 5-10 m water depth and therefore potential for numerous longline systems. The high primary productivity, as indicated by the colour and turbidity of the water, suggests sufficient food for filter feeding bivalves. The water quality of the Erakor Lagoon, however, poses a major constraint on its potential for aquaculture of filter feeding bivalves. The water is polluted by the septic tank sepages in the lagoon (Nerland, 1985 and Naidu and Morrison, 1988). High faecal coliforms (14-152/100 ml in the water) and elevated levels of dissolved phosphates and nitrates have been reported (Naidu and Morrison 1988) as well as depressed dissolved oxygen levels (Yuen, 1980). There is also the danger of red tide blooms possibly resulting from localised eutrophic conditions.

The Eratap Lagoon is a much smaller lagoon compared to the Erakor Lagoon. It appears to have similar characteristics to the Erakor Lagoon including a narrow entrance channel, extensive areas of shallow reef flats, and probably limited water movement. It is more sheltered from prevailing winds than Erakor Lagoon.

Hickman (1989) concluded that the mangrove oyster and the local mussel species could be used to assess intensive farming techniques, in preference to introducing a new species in the form of the tropical green mussel.

17 REPTILES

17.1 TURTLES

17.1.1 The Resource

Species present
The main species found in Vanuatu are the green turtle (*Chelonia mydas*) and hawksbill turtle (*Eretmochelys imbricata*). Leatherback (*Dermochelys coriacea*) as well as the olive or Pacific Ridley (*Lepidochelys olivaccea*) turtles have also been observed.

17.1.1.1 Distribution

Sea turtles are marine reptiles, which have inhabited the earth for over 100 million years. Seven species of turtles exists wordwide with all but one occurring in the Pacific region. The most frequently seen species in the Pacific are the hawksbill and green turtle, although the leatherback (*D. coriacea*), loggerhead (*C. caretta*) and olive or Pacific Ridley (*L. olivaccea*) turtles also occur. However, Leatherback turtles in the Pacific are highly endangered and there are suggestions that they may be on the verge of extirpation (Spotila et al., 2000). Nesting females have declined precipitously in Malaysia (Chan and Liew, 1996) and Costa Rica (Spotila et al., 2000).

Little information is available on marine turtles in Vanuatu but the hawksbill and the green turtles are the most common species of sea turtle found. The olive or Pacific Ridley, and the loggerhead are probably rare. Information collected by Dickinson (1981) indicated that turtles can be encountered almost throughout the archipelago, from Anietyum in the south, to the Banks/Torres group in the north (Groombridge and Luxmoore, 1989). The turtle most frequently encountered by divers in reef areas around Vanuatu is the hawksbill.

The leatherback occurs in small numbers. Archival data reviews and interviews on knowledgeable coastal residents by George *et al*, (2004), indicated that leatherback turtles are known throughout many islands of Vanuatu. They are often seen at sea as they migrate to nesting places. The information collected by Hickey *et al*, showed that often a name in the vernacular to identify them. For example, on Aneityum the leatherback is known as “naho yau” which translates as “whale turtle”, referring to its size. On Akhamb Island off southern Malekula, they are known as “nev marmaj”, which translates as “devil turtle”. It is said that in this area, leatherbacks are avoided and not eaten due to their unusual appreance and belief that they are bad spirits.

17.1.1.2 Biology and ecology

The Hawksbill turtle feeds on a diet of invertebrates, sponges and soft corals. The green turtle, by contrast, is mainly herbivorous, feeding on seagrasses and algae. Because the seagrass beds often do not occur close to suitable breeding beaches, green turtles may have to migrate from a resident habitat to breeding beaches and back at intervals. Loggerheads and olive Ridleys are also carnivorous and, with the hawksbill, do not appear to migrate to the same extent as the green turtle, though some long distance movement has been recorded (Pickering, 1983). Movements of the Olive Ridley are particularly poorly known. The loggerhead nests mainly outside the tropics on subtropical and warm temperate coasts.


Hawksbill turtle


Leatherback turtle


Green turtle

While green turtles often nest together in large numbers (the sites are called rookeries) the nesting of the hawksbill is diffused, with no great concentrations of nests. The single largest known green turtle rookery is Raine Island on the northern Great Barrier Reef in Queensland, with 80,000 nesting females per year (Pickering, 1989). Other major rookeries occur around Australia, on the Caribbean coast of Costa Rica (Tortuguero), the Pacific coast of Mexico, Ascension Island, the coasts of Oman and Pakistan and islands in the Mozambique Channel (Pickering, 1989). Hawksbill nesting density is low throughout its range, with moderate concentrations in a few localities such as the Torres Straits islands of Queensland, the southern Red Sea and the Gulf of Aden and the Arnavon Islands near Santa Ysabel in the Solomon Islands.

There is evidence that 7-14 months after hatching, young green and hawksbill turtles spend their time drifting passively in beds of floating seaweed, such as *Sargassum* spp., in the deep ocean. Green turtles are then thought to spend a developmental period in inshore estuarine, coastal and reef habitats before moving to their main resident areas (Pickering, 1989).

Leatherback turtles, *Dermochelys coriacea*, have not previously been reported nesting in Vanuatu. A review of archival data, unpublished reports, interviews with key informants from coastal communities, and a nesting beach survey carried out by George Petro, Francis Hickey and Kenneth Mackay (2004) indicated that leatherbacks nests on a number of Islands, including, Pentecost, Ambrym, Malekula, Epi and Efate. A number of other islands including Gaua, Ambae, Tanna, Aneityum and Santo also reported regular nesting activity up until about 20 to 30 years ago. It is possible that these areas are still occasionally used for nesting by small numbers of leatherbacks (George *et al*, 2004).

On Efate Island on beaches adjacent to Port Vila, the capital city, one to two females nest, but not every year. The nesting beaches are in the Mele Bay area adjacent to Port Vila the capital city inaddition to Teouma Bay, south of the captital. The Mele Bay nesting beaches are in developed areas particularly real estate development, a tourist resort and a golf course. George *et al*, (2004) suggested that there are only 1-2 females nesting but not every year. This nesting in Mele and Teouma Bays at 17.5^{o} S, may, however, represent the southern most reported nesting site for the Western Western Pacific leatherback turtle.

Epi Island appears to have the largest number of nests, with two nesting areas. The South West exposed coasts in the Votlo area probably has as manay as 20-30 nesting females (George et al, 2003). A smaller number appear to nest on the East Coast around Big Bay. Malekula would appear to have the greatest number of nests after Epi (George et al, 2004). Malekula appears also to be only island where leatherbacks are still consumed. All nests occurred on black sand beaches often associated with rivers. Tabulated below are recent survey results of leatherback nesting sites at Votlo, south Epi by George *et al* (2004).

Table 86 Summary of Results of Nesting Beach Survey at Votlo, Southern Epi (George *et al*, 2003)

Activity	**Green**	**Hawksbill**	**Leatherback**	**Grand Total**
False Crawls	10	3	5	**17**
Nesting	15	2	31	**46**
Grand Total	**25**	**5**	**36**	**63**
Number Tagged	2	0	9	**11**

(Refer to Appendix 4 for summarized information on Leatherbacks in Vanuatu)

17.1.2 The Fishery

17.1.2.1 Utilization

The major sea turtle products traded internationally are raw and worked shell, particularly from the hawksbill turtle; raw skin and processed leather, from Olive ridley and green turtles, oil for use in cosmetics and some meat products from the green turtle. The hawksbill turtle faces a special problem as its beautiful shell is the source of "tortoiseshell", which is made into jewellery and other carved items (Daly, 1989). Very little, if any, green turtle shell is traded internationally as it is very thin and does not have the physical properties of tortoiseshell, making it unsuitable for manufacturing purposes.

Pacific people have been exploiting turtles for subsistence purposes for thousands of years and the taking of limited numbers of turtles for food and traditional local use continues today. However, as with the exploitation of some other marine resources, in recent times the hunting of turtles in some areas has become more commercially motivated rather than traditional.

The hawksbill and green turtles are both exploited for meat and eggs in Vanuatu. The use of shell is thought to be minimal. In areas where they are abundant, green and hawksbill turtles have been hunted for centuries to supply the basic needs of the traditional subsistence village community, for example, food, tools, decoration and items for trade. Hunting practices, which have evolved over many years represent the oral knowledge of the village relating to the turtle, where it lives, its habitats and the most efficient ways of hunting it. The complex social interactions involved in observing the many rules, rituals and traditional ownership patterns contribute to make the hunt an organised and disciplined affair and the consumption of turtles a special social event in the village. Where they occur these traditional patterns of capture and consumption have helped to regulate the exploitation of sea turtles.

The killing of turtles for consumption does not occur on all islands in Vanuatu. A questionnaire survey carried out in 1989, by the Environment Section of the Vanuatu Department of Physical Planning and Environment, showed that on some of the islands the killing of such animals is a taboo and on others, only the chief is allowed to kill or can permit such killing. On other islands such as the Masklyne Islands marine turtles are only hunted during the yam season.

As regards to leatherbacks, their body size often makes it impossible to harvets them when found swimming as with other species of marine turtles found in Vanuatu, as they are too large to be hoisted into canoes or small fishing crafts. For those local communities that consume leatherbacks such as the Malekula coastal communities, they harvest the leatherbacks when found on nesting beaches.

17.1.2.2 Production and marketing

From 1976 to 1988 an average of 50,000 adult hawksbill turtles were killed each year for international trade (Daly, 1989). The current major exporting countries of tortoiseshell are Cuba, Haiti and Jamaica in the Caribbean; the Maldives and Comoros Islands in the Indian Ocean and the Solomon Islands and Fiji in the Pacific. Japan is by far the major importer providing the stimulus behind the international trade in tortoiseshell although Singapore, Taiwan, Hong Kong and China also import this shell for their carving industries. In 1988, Japan imported just under 30 tonnes of tortoiseshell which represented some 28,000 adult hawksbills (Daly, 1989).

There is little information available from most Pacific nations on the extent of sea turtle product exports although it appears that only shell is currently traded internationally. The most reliable source for figures on the exports of tortoiseshell from the Pacific is the Japanese Custom Statistics (Daly, 1989). These show that during the period of 1985 to 1988, Japan imported significant quantities from both the Solomon Islands and Fiji.

Table 87 Export figures of tortoiseshells from the Solomon Islands and Fiji to Japan.

Year	Solomon Islands	Fiji
1985	1556 Kg	294 Kg
1986	1793 Kg	497 Kg
1987	4723 Kg	1859 Kg

1988	3911 Kg	817 Kg

The only other recorded exports of tortoiseshell to Japan from the Pacific were from Vanuatu as follows, as reported by Daly (1989):

Table 88 Exports of turtle shells from Vanuatu

Year	**1980**	**1984**	**1985**
Weight (kg)	33	25	12

McElroy and Alexander (1979 quoted in Groombridge and Luxmoore 1989) estimated the annual catch of turtles in the Maskelynes Group (Malekula), the principal turtle fishing area, to amount to 60-120 turtles, evenly split between the hawksbill and green turtles. Eggs and nesting were said to be taken whenever they were found. The hunting pressure was localised and never intense, and was not thought to have had much impact on the turtle population. The majority of the turtles are deliberately caught at sea; females are also captured on the beaches.

At present turtle killings by coastal communities is minimal, given the amount of awareness work carried out by the Environment Unit, Fisheries Department and the "Wan Smol Bag" theater group for conservation of marine turtles. There are now turtle monitors in all islands of Vanuatu. They meet every year to discuss turtle conservation issues.

17.1.3 Stocks Status

There are no consistent current indices of abundance for sea turtles within the Vanuatu waters. However green and hawksbill turtles are the only known species nesting within the Republic. Information on the leatherback turtle indicate that it occurs in some parts of the group. Only one or two nesting beaches are known. The green and hawksbill turtles are common in the extensive reefs and shallow areas of the group.

The most important nesting area in the group is at south Malekula Island. Important mainland nesting of green turtles occurs at South West Bay, and particularly Lambobe beach. Small numbers of hawksbill turtles also nest here. A rough estimate of the numbers nesting each year is from 40 to 120 turtles (Groombridge and Luxmoore 1989). The Maskelynes form a group of offshore islands off the southern coast of Malekula where turtles are particularly plentiful. Regular nesting of both species also occurs within the group, particularly at Seior and Laifond islands. Sakau and 2 small islands close to Aham Island are used occasionally. Other notable areas for nesting are southeast of Epi Island, Emae Island, and in the north amongst the Torres group. The nesting season for both species extends from September to early January.

During a one week turtle survey in the Maskelynes islands, south Malekula, by the Vanuatu Environment Unit in November 1992, only five turtles were tagged, 3 greens and 2 hawksbill turtles (Environment Unit, 1992.). No turtle nesting was sighted. The results of the survey seem to indicate a declining number of turtles around the Maskelynes islands.

17.1.4 Management

The Department of Fisheries having recognized the urgent need for conservation of the marine turtes and the need to increase its population established a number of turtle nurseries in collaboration with some private sector investors. The nurseries were able to rear up to 200 baby turtles, mainly Hawks bill. Newly hatchery turtles would be brought to these nurseries for rearing to a certain size, which is deemed sufficient to avoid predation. This intention is to increase survivability rates for the baby turtles. The three nurseries successfully released over 300 tagged turtles in total. Two of the nurseries are now closed. Only one nursery is still in operation managed by the Congula Cruises management.

17.1.4.1 Current legislation/policy regarding exploitation

Vanuatu is a party to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (Date of entry-15 October, 1989). The convention prohibits the trade of any turtle product.

The Fisheries Regulations Order No. 49 of 1983 protects the harvesting of turtles as follows:

No person shall

(i) disturb, take, have in his possession, sell or purchase any turtle eggs;

(ii) interfere with any turtle nest; or

(iii) sell, purchase or export any turtle or the shell thereof of the species *Eretmochelys imbricata*, known as the hawksbill turtle.

17.4.1.2 Recommended legislation/policy regarding exploitation

In order to make the regulations more meaningful, consideration should be given where traditional customs are involved. The Department of Fisheries in consultation with relevant institutions develop a management plan for all species of marine turtles in Vanuatu. The management plan must establish a quota system, and a close season of harvest of the turtles and a ban on killing of Leather Back turtles.

APPENDIX 4 Reports of Leatherback turtles in Vanuatu (George *et al*, 2004)

Island	Location	Beach or Area	Date	No. Turtles				Notes
				Crawls	Nests	Tagged	Eaten	
Ambae	West Ambae East Ambae	Devils Rock Lolowai area						Limited habit on Ambae but some black beaches & nesting reported in past, some consumed 20-30 years ago
Ambrym	Port Vato		1 Jan-2003			1(~3m)		All Island beaches are black sand. Tagged turtle later seen swimming
			2004	None				
Efate	Mele Bay	Black- sands	1999/ 00 2003		1	1		Caught coming ashore, tagged and released but in injured state. Main nest could not be found but one small egg was found
		Melemaat	1997/98	2	1			Photographed & on postcard
	Teouma Bay		99/ 00				1	Black sand beach with river, turtle was consumed. Fisheries Department laid charge
	No location given		30 July 1997			1 (127cm)		
Epi	SW Epi	Votlo	12 Nov 2002 –15 Feb 2003	36	31	9		See nesting survey report for additional information Storm surge destroyed some nests, some hatchlings seen Jan-03
	SW Epi	Votlo	Late Jan-04		5			
		Port Quimie	Jan-04		3	1		4-5 km suitable beach, north end towards Votlo one nest destroyed by storm
	East Coast	Big Bay	Jan-04		1			4-5 km Black sand beach, limited surveys
Malekula	SW Bay	Dixon Reef to Bamboo Bay	Jan-04	2				3 km beach no regular monitoring
	SW tip	Malfakal	2000	Some				Suitable beaches between Caroline Bay & Malfakal
	SE Malekula	Maskelyne Islands	Few years ago				1	Killed but covered in sores so would not eat it.
		Unua	Jan-02				1	Large area of suitable habitat—river estuary & 3 long black sand beaches

Island	Location	Beach or Area	Date	No. Turtles				Notes
				Crawls	Nests	Tagged	Eaten	
	East Coast	Blacksand (N of Port Sandwich)	Feb-04				1	Nesting female eaten
	NW Malakula	Wilak	1997				1	4 km long black sand beach
Pentecost	Bay Martelli	Poinkros	2000				1	Nesting female eaten

17.2 CROCODILES

17.2.1 The Resource

Species present
Crocodylus porosus.

17.2.1.1 Distribution

The only island in Vanuatu known to have had a breeding population of the estuarine crocodile, *C. porosus*, is Vanua Lava Island, one of the islands in the Banks/Torres group, north of Vanuatu.

It is thought that the crocodile population on Vanua Lava was a natural extension of the populations of the Solomon Islands (Messel and King, 1992). The crocodile populations, though small, on Nendo and Vanikoro islands in the Solomon Islands are only some 250 to 300 km to the north-west of Vanua Lava, a swimming distance for the strong and long distance swimming *C. porosus*.

17.2.1.2 Biology and ecology

Little is known about the biology and ecology of the crocodiles in Vanuatu.

17.2.2 The Fishery

17.2.2.1 Utilization

The people of Vanua Lava Island strongly fear and dislike crocodiles.

17.2.2.2 Production and marketing

There is no production and marketing of crocodile skin or flesh in Vanuatu. However, in other Pacific territories, for example, Papua New Guinea there is a crocodile skin export industry.

17.2.3 Stocks Status

Little is known about the *C. porosus* population on Vanua Lava. A survey carried by David Luders, in 1983 (quoted in Messel and F.W. King, 1992) did not sight any crocodile. However Luders gathered important local information on crocodiles in Vanua Lava. He stated in his report that prior to 1972, a well known local personality, Mr. Jimmy Jones who occupied a plantation on the Selva River (Vanua Lava) for many years, reported daily sighting of crocodiles of all sizes during the 1960's basking on the sandbanks near the mouth of the river. He reportedly had shot some (the last one he shot was in 1978, 5.5 m in length). Nests were occasionally found in the Selva river area. There is little doubt that it was a breeding population, and total numbers may have ranged up to 200. In his commentary and conclusion Luders stated that it seemed certain that the 1972 cyclone reduced the crocodile population of Vanua Lava almost to nil, the bulk of the population may have been washed out to the sea and suffered an unknown fate. The habitat of the main centre of population (Selva river) was altered unfavourably.

A second survey on the Vanua Lava crocodile population was carried out by M.R. Chambers and D. Esrom of the Vanuatu Environment Unit, Ministry of Lands, in 1989. Chambers and Esrom (1989) concluded that there were very few crocodiles remaining on the island, perhaps only two or three. However, no crocodiles were seen during the survey.

In September 1992, a third crocodile survey was conducted on Vanua Lava, headed by Professors H. Messel and F.W. King, in collaboration with the Vanuatu Environment Unit. Only two large belly slides, some days old, were seen 250 metres upstream of the mouth of Selva River.

Messel and King (1992) concluded that the crocodiles of Vanua Lava are on the verge of extinction and that only one large male *C. porosus* is remaining for certain although there might be a second animal, smaller in size. Since no juvenile crocodiles were sighted during the survey, it was postulated that if there is a second animal then it is a second male or an immature female. There is no longer a breeding population remaining, though breeding used to occur in the past.

17.2.4 Management

17.2.4.1 Current legislation/policy regarding exploitation

No management legislation exists concerning crocodiles in Vanuatu.

17.2.4.2 Recommended legislation/policy regarding exploitation

Results of recent surveys seem to indicate that the crocodile population on Vanua Lava has become almost extinct locally. In addition, natural parameters, e.g. cyclones, are indicated as having a major part to play in the process.

18 OTHER RESOURCES

18.1 SEA CUCUMBERS

18.1.1 The Resource

Species present

The most recent survey conducted on this resource was a project of the Australian International Development Assistance Bureau (AIDAB) conducted in 1988. Eighteen species were recorded in areas of Vanuatu and include, *Actinopyga echinites*, *A. mauritiana*, *A. miliaris*, *A. palauensis*, *Bohadschia argus*, *B. similis*, *B. vitiensis*, *Holothuria* (*Acanthotrapeza*) *coluber*, *H.* (*Halodeima*) *atra*, *H*. *(Halodeima*) *edulis*, *H*. (*Mertensiothuria*) *leucospilota*, *H*. (*Metriatyla*) *scabra*, *H*. (*Microthele*) *nobilis*, *H*. (*Microthele*) *fuscopunctata*, *Stichopus chloronotus*, *S. variegatus*, *Synapta maculata* and *Thelenota ananas*.

18.1.1.1 Distribution

Chambers (1990) recorded the distribution and occurrence of sea cucumber, by species, for sites visited during the above study. In addition, distribution within each location was broken down into distribution by different habitats (refer to Champers, 1990, for these details). For the purposes of this document, species occurrence (distribution) is summarised below for locations under the different islands and groups of islands, as recorded by Chambers (1990).

Table 89 Species distribution

Island	Loactions	species
ANEITYUM	Inyeug platform reef	*H.atra, B.argus, S.chloronotus*
	Anelgohat Bay	*A.mauritiana, S.maculata*
	Port Patrick	*S.chloronotus*
EFATE & OFF SHORE ISLANDS	Moso, southwest shore	*H.atra, S.chloronotus*
	Moso, east side	*H.atra, H.fuscopunctata*
EMAE – Cooks Reef	Platform reef, west side	*A.mauritiana, B.argus, H.atra, H.fuscopunctata, S.chloronotus, T.ananas*
	Platform reef, centre	*A.mauritiana, B.similis, H.atra, H.fuscopunctata, S.chloronotus, T.ananas*
	Platform reef, northeast	*A.mauritiana, B.argus, H.atra, S.chloronotus, T.ananas*
MALEKULA AND OFFSHORE ISLANDS	Metai	*A.echinites, A.miliaris, A.palauensis, B.argus, B.similis, B.vitiensis, H.atra, S.maculata*
	Sakao, south	*B.argus, H. atra, H.nobilis, S.chloronotus*
	Sakao north	*H.atra, H.edulis, S.chloronotus, S.maculata*
	Cook Bay	*B.vitiensis, H.coluber, H.atra, H.edulis, S.variegatus*
	Gaspard Bay	*H.atra, H.edulis, H.scabra, S.chloronotus*
	Atchin	*A.mauritiana, H.leucospilota, T.ananas*
	Port sandwich	*H.atra, S.chloronotus*
PENTECOST AND OFF-SHORE ISLANDS	Wanuru	*A.mauritiana*
	Banmatmat	*H.atra*
	Loltong	*Nil*
SANTO AND OFFSHORE ISLANDS	Big Bay	*Nil*
	Hog Harbour	*Nil*
	Champagne Beach	*H.atra, H.nobilis, T.ananas*
	Turtle Bay	*H.fuscopunctata, S.chloronotus, S.variegatus*

	Palekula Bay	*H.atra*
GAUA	Lesalau Bay Lesalau Lagoon	*H.atra, H.edulis, S.chloronotus, S.variegatus* *H.atra, H.nobilis, S.chloronotus*
REEF ISLANDS	Platform reef, south Platform reef, northwest Enwut and Watansa	*B.argus, H.nobilis* *A.mauritiana* *H.atra, H.leucospilota*
UREPARAPARA	Lorup Bay, south Lorup Bay, north Lorup Bay, village	*Nil* *A.miliaris* *Nil*

The most diverse sites were the three sampling stations at Cook Reef (6 species each) and the intertidal reef crest and sand flats east of Metai Island in the Maskelyne Islands (7 species).

Bacteria constitutes the major nutritional component for most holothuroids. Therefore "the complex relationship between bacterial populations and sediment structure may have a major influence on the distribution of holothuroids" (Preston, 1993).

18.1.1.2 Biology and ecology

Sea cucumbers belong to the phylum *Echinodermata*. This phylum contains 17 classes, 12 of which are extinct. There are four subphyla (*Homalozoa extinct*) which include; sea lollies and feather stars (*Crinozoa*), Starfishes, brittle stars and basket stars (*Asterozoa*), spiny-skinned, for most members have defensive spines on the outside of their bodies (Campbell, 1985).

There are 900 echinoderms known as Beche-de-mer or sea cucumbers that belong to the class – *Holothuroidea*. The body of the holothuriod is not drawn out into arms and the mouth and anus are located at different ends of the body. The class is distinguished from other echinoderms by the reduction of the skeleton to microscopic ossicles and by modification of the buccal podia into a circle of tenticales around the mouth (Ruppert and Barnes, 1994).

Most sea cucumbers are dioecious (separate sexes) and all species can reproduce sexually. Spawning occurs in spring or summer in the tropics (Rand, 1984). During spawning the eggs are caught by the tentacles and are transferred to the sole or the dorsal boday surface for incubation. The eggs pass from the gonads into the coelom where they are fertilized (Ruppert and Barnes, 1994). Development begins to take place within the coelom and the young leave through a rupture in the anal region. The embryo then becomes planktonic. There are two larval stages. On the third day of development the larval stage called auricularia is reached. The second stage ia a barrel shaped larva, called doliolaria, where the ciliated band has become broken up into three to five ciliated bands.

Sea cucumbers have a life span of 5 – 10 years, maturing after 3 years depending on the species (Rand, 1984). Predators include the triton, starfish, lobsters and rays, not forgetting humans.

Sea cucumbers are deposit and suspension feeders, swallowing the upper few millimetres of sediment on which they live. The sediment consists of inorganic compound, organic detritus, micro-organisms and their own or other animals' faecal material with bacteria making up the major nutritional component for most species. They generally feed continuously or have a daily rhythm in their feeding frequency, often related to light levels. Species that live in reef flat areas "vacuum" the surfaces of their habitat cleaning off the film of sediment that settle there.

Literature on the biology and ecology of sea cucumber in Vanuatu is very limited. Apart from AIDAB funded study during 1988, the only other report that touched on these subjects was that of Baker (1929, quoted in Chambers 1990). That report recorded four species of sea cucumber arranged in clear zones in the shallow fringing reef lagoon at Gaua Island. Speaking on the general results of the AIDAB survey carried out in 1988, Chambers (1990) noted that

> *"overall, the beche-de-mer showed no preference for the major habitat types of reefs, lagoon or intertidal zones, with averages of 2.1, 2.5, and 2.4 species per site respectively. Within these habitats, the exposed sites may have higher diversity than the sheltered*

sites: lagoon - 3.0:1.3 species, intertidal - 2.6:1.8 species and reefs - 2.8:1.5. However, as the data are highly variable more sites would need to be evaluated to confirm this apparent trend".

Conand (1989) gives a review of what is known of the biology of the main species of holothurian exploited commercially in the South Pacific. Additional information is provided in Preston (1993). Summaries of information from both sources on certain species of commercial interest are given in Appendix 4.

18.1.2 The Fishery

18.1.2.1 Utilisation

Sea cucumber does not form any fishery for local consumption by Ni-Vanuatu and there is no local market for them. A revival in sea cucumber fishing and processing was reported in 1973 (Baird, 1973). This indicates that processing for export had occurred earlier but abandoned until the early 1970's. Latham (1929, quoted in Dalzell, 1990) reported that bêche-de-mer was one of the principal exports of Vanuatu at the beginning of the 20th century. Dalzell (1990) reported that exports of bêche-de-mer were officially terminated in Vanuatu after 1988 due to the consistently poor product being exported by inexperienced processors. However, after an SPC processors training course (July-August 1989) four locals were actively processing bêche-de-mer for export in 1990 (letter to SPC dated 5 June 1990).

There are at present 5 licensed local companies involved in the exports of dried beche-de-mer products. Main harvesting areas have concentrated on Emae Island, Banks group, Efate Island, the Cook reef, the Masklyne Islands, Epi, and Atchin Island.

18.1.2.2 Production and marketing

Conand (1989) classified bêche-de-mer species according to their commercial value with *H. scabra*, *H. fuscogilva* and *H. nobilis* having high value, *A. echinites*, *A. miliaris* and *T. ananas* with medium value and *H. atra*, *H. fuscopunctata* and *H. mauritiana* with low commercial value. Baird (1973) reported that this industry could well be expanded considering the extensive coastline available in Vanuatu. He reported that bêche-de-mer fishing and processing were revived by a Mr Autrand in one or two villages. Mr Autrand was reported to have successfully marketed the product "on behalf of the villages concerned" and that demand was high and prices being paid were good. No figures of production were reported.

The export of bêche-de-mer products from Vanuatu between 1983 and 1989 are recorded in the following two tables. Exports were to Hong Kong, Singapore and Australia.

Table 90 Beche-de-mer exports from Vanuatu (1983 – 1989)

Year	Quantity (tons)	Value (VT)	Source
1983	6	3,121,000	Fisheries Department Annual Report for 1983 and Preston (1993)
1984	3	1,707,000	Fisheries Annual Report for 1984 & Second National Development Plan (1987-1991) & Preston (1993
1985	6.8	5,251,000	Fisheries Department Annual Reports for 1986 & 1987.
1986	4	2,837,000	Fisheries Department Annual Reports for 1986 & 1987 & Preston (1993)
1987	1	938,000	Fisheries Department Annual Reports for 1987 & 1989 & FFA. 1990.
1988	15	3,291,000	Fisheries Department Annual Report for 1989 & Overseas Trade Part II 1985-1990 Exports
1989	24	9,377,000	Fisheries Department Annual Report for 1989

Data obtained from records of Export Permits and Certificates of Origin gave an indication of bêche-de-mer exports, species involved and amount for 1990 as follows.

Table 91 1990 beche-de-mer exports

Date	Species	Quantity)kg)	Value/kg (US$)	Total Value
24-Apr-90	Blackfish	1,500.0		
	Greenfish	600.0		
	Black Teatfish	660.0		
	Surf Redfish	400.0		
	Sandfish	700.0		
	Prickly Redfish	60.0		
Total		**3,920.0**		**2,442,000 Vt**
7-May-90	Bêche-de-mer	300.0	12.00	US$3,600.00
13-Jul-90	Sandfish	327.0	12.00	US$3924.00
	Blackfish	69.0	4.00	276.00
	Teatfish	20.0	10.00	200.00
Total		**416.0**		**US$4,400.00**
18-Oct-90	Black Teatfish	644.4	12.00	US$7,732.80
	Sand Redfish	87.6	7.00	613.20
	Prickly Redfish	8.8	9.00	79.20
Total		**740.8**		**US$8,425.2**
7-Dec-90	Black Teatfish	200.0	9.00	US$1,800.00
	Prickly Redfish	8.8	12.00	105.60
	Prickly Redfish	8.8	12.00	105.60
	Surf Redfish	87.6	9.00	788.40
Total		**296.4**		**US$2,694.00**
TOTAL '90		**5,673.2**		**US$37,719.2**

No export data was located for the period between 1991 and 1992. However the following export figures were obtained from records of Permits to Export Fisheries Products between May and August 1993. During this 3-month period, 7.5 t, worth about USD 55,000 was exported.

Table 92 May 1993 – August 1993 Beche-de-mer exports

Date	Species	Quantity kg)	FOB/kg	Total Value (US$)
8 June 1993	Processed bêche-de-mer	2,245	USD 7.00	15,715.00
Sub-total		**2,245**		**15,715.00**
7 July 1993	Blackfish	694	USD 4.00	
	Sandfish	543	USD 5.00	
Sub-total		**1,237**		**5,491.00**
9 August 1993	Black teatfish	720		
	Curryfish	480		
	Tigerfish	1,240		
	Vula	300		
	Prickly redfish	240		
	Surf redfish	500		
	Lollyfish	400		
Sub-total		**4,000**		**33,530.00**
TOTAL		**7,482**		**54,736.00**

Summarized in the table below are beche-de-mer exports from 1996 to 2004.

Table 93 Beche-de-mer exports

Year	Quantity (kg)	Value (VT)
1996	1,771	-
1997	38,100	8,352,874
1998	19,086	7,828,280
1999	18,220	5,079,170
2000	25,500	4,181,604
2001	47,694	17,609,324
2002	8,402	5,122,676
2003	25,069	11,906,346
2004	14,094	13,934,242

18.1.3 Stocks Status

The 1988 AIDAB funded survey recorded the presence of all the major commercial species of sea cucumber in the survey sites in the archipelago. These species include: *H. nobilis*, *A miliaris, A. echinites, A. mauritiana, T. anas, H. scabra*, and *H. atra*.

Annual export figures for bêche-de-mer from Vanuatu between 1983 and 1990 were relatively low ranging from 1-6 tonnes except for 1988 and 1989 when 15 and 25 tonnes were exported respectively. About 7.5t were exported during a 3-month period in the middle of 1993. Chambers (1990) reported that "harvesting is been carried out intermittently at periods of one or more years, thus allowing stocks to recover and build up between successive harvests". Because of the lack of information on CPUE etc, on this particular fishery, no meaningful estimates of level of sustainable exploitation can be made.

Baker (1929-quoted in Chambers, 1990), recorded high densities of up to 5 sea-cucumbers per square meter for *S. chloronotus* and *H. atra* in the shallow fringing reef lagoon at Gaua Island. Wright (1989) reported that a two-week survey of the archipelago was undertaken by a Fiji Fisheries Division staff in 1983. However, no report has been published but he noted that "the Draft Fisheries Management Plans prepared in September, 1983 revealed that the survey recorded that the black teatfish, (*H. nobilis*) was the most abundant holothurian encountered".

Chambers (1990) found generally low densities of sea cucumber (rarely exceeding 1/100 m^2) at 8 sites in the Maskelyne Islands and Atchin Island with the exceptions of high densities of *S. chloronotus* at a site on Moso Island and *H. leucospilota* in rock pools on the north shore of Atchin Island. However, both species have no commercial value. The author noted that the low densities may be typical for much of Vanuatu except that very high densities of certain species (mostly of commercial* value) were recorded by the same author in 1987 at various sites in Port Vila Harbour and the Ekasuvat Lagoon as follows (in descending order of value):

Table 94 Density of beche-de-mer by species in Port Vila habour & Ekasuvat lagoon

Species	Numbers per 100 m square
*H. scabra**	43
*A. miliaris**	785
*H. atra**	214
H. edulis	21

Table 95 Densities (nos/100 m^2) of sea cucumbers at the 8 sites mentioned above by Chambers (1990):

Species	Metai Intertidal & reef crest	Sakao south intertidal	Sakao south reef crest	Sakao north intertidal	Sakao north reef crest	Cooks Bay intertidal	Cooks Bay reef crest	Atchin reef crest
A. echinites	0.1							
A. mauritiana	0.1							1.6
A. palauensis	0.1							

B. argus			0.1					
B. similis	2.2							
B. vitiensis	0.1					<0.1		
H. coluber						<0.1		
H. atra	0.7	0.4		1.5	0.1	0.9	0.3	
H. edulis					0.9		0.2	
H. nobilis		0.1						
S. chloronotus			4.9		0.7			
S. variegatus							0.2	
S. maculata	0.1			0.1				
T. ananas							<0.1	

Stock assessment surveys of beche-de-mer carried out by Fisheries Department the Shepherd Outer Islands from September – October of 1998 indicated that Emae Island has the stock densities enough to sustain commercial harvesting, however, this would have to be carefully managed to ensure the sustainability of the resource. The overall predominant species is lollyfish, which occurs in highest densities on the northeastern side of Emae Island. Lollyfish has a very low commercial value. The smaller islands of Buninga, Mataso and Tongariki do not have densities to withstand harvesting above subsistence levels.

In 2003 the Fisheries Department carried out an intensive sea slug survey around Epi Island. The following sites were surveyed, Lamen Island, Nuvi, Nikaura, Valesdir, Mavelau, Burumba, Maso, Ponkovio, and Alak. The results of the survey showed that Epi has a healthy stock of sea slugs, with the predominant species being lollyfish and green fish.

The overall status of sea slug stocks in Vanuatu is at a very critical stage, whereby, sustained fishing pressure can result in depletion of the stocks. The fishing pressure is a direct result of monetary needs of rural communities through out Vanuatu.

18.1.4 Management

Management of the exploitation of the sea cucumber fishery in the South Pacific countries has been very minimal. This has been partly due to the fact that the bêche-de-mer industry in the region is not an old tradition and the absence of scientific information on which to base management. As a result this particular fishery has been known to be characterised by periods of heavy exploitation followed by a resting period during which the resource is able to recover (Preston, 1993). One of the factors that has contributed to the control of harvesting is that low returns obtained on small-sized products usually spontaneously restricts fishing to large specimens (Conand, 1989).

18.1.4.1 Current legislation/policy regarding exploitation

The Fisheries Regulation of 1988 prohibits the exportation of bêche-de-mer without the written permission of the Minister and in accordance with conditions he specifies.

Ministerial Order of 1991 limits the export of dried bêche-de-mer to an annual quota of 35 t.

18.1.4.2 Recommended legislation/policy regarding exploitation

Chambers (1990) recommended that:

> "the correct strategy with regard to bêche-de-mer harvesting in Vanuatu is to collect intermittently from sites which are both large enough and support sufficient densities of commercial species to be economic. Stocks should then be left for however long it takes them to recover to economic levels. There are probably few such areas in Vanuatu".

Records of annual exports of dried bêche-de-mer from Vanuatu have been consistently well below the legal quota. This seems to indicate that the quota (35 t a year) applied is very much unfounded and could well be above the sustainable level of exploitation for the fishery. The reason of the low production so far is not apparent but it can mean that the resource is not large enough to be

expanded to meet the quota or there is a lack of enthusiasm by the collectors and exporters to expand.

Given the above situation, the Fisheries Department needs to conduct an assessment of the resource in order to obtain exploitable levels of the available stocks and to avoid legislating meaningless (or even damaging) regulations. A total only 3 companies should be allowed to operate and process beche-de-mer in Vanuatu.

Conand (1989) and Preston (1993) describe several options available for the management of sea cucumber resources for sustainable utilisation. One such means is the application of minimum size limits regulations. Conand (1989) notes:

> *"the seasonal fishing ban can hinder exports, since the buyers on the Hong Kong and Singapore markets have always insisted that suppliers should be regular. A longer closed season can be considered where yields drop drastically. It is difficult to enforce closures of fishing zones and their boundaries must respect local customs, when these non-mobile resources are exploited under a system of traditional ownership. Limiting fishable sizes tends to favour recruitment. When applied to catches, such restrictions are hard to verify but when applied to the processed product, they are realistic and can be checked through exports. The limits should be set out on the basis of scientific results relating to size at first sexual maturity".*

Length and weight values for processed bêche-de-mer with corresponding total wet length and weight at first sexual maturity have been calculated for some species with commercial value. These can then be used as a basis for setting legal size on the processed product (Conand, 1989). However, the author notes "that these are minimal and that better knowledge about growth remains essential so as to be able to leave individuals undisturbed for one or more breeding seasons before harvesting them".

In the absence of data on which to base a reasonable minimum export quota, perhaps the minimum quantity required by market or minimum amount to make operation economically feasible could be used.

Appendix 5:

Biological information of some sea cucumbers species exploited commercially in the Pacific region (Conand 1989 and Preston, 1993).

***H. scabra* and *H. scabra* variety *versicolor* (the "sandfish"):**
Sexes are separate and sex-ratio does not significantly diverge from 1:1, with individuals showing a single annual sexual cycle. Reproduction is sexually and takes place mainly during the warmer months, peaking in October-December, with absolute fecundity ranging from 9-12 x 10^6 oocytes per gram of ovary weight. Sizes at first sexual maturity for *H. scabra* and *H. scabra* var. *versicolor* were found to be 140 g and 320 g drained weight respectively with corresponding lengths of 16 cm (total weight 184 g) and 22 cm (total weight=490 g). Growth is difficult to measure, however, Shelley (1985) studied the species length-frequency and concluded that in the size range of 10-25 cm *H. scabra* were growing at 0.5 cm per month, equivalent to an average monthly whole weight increase of 14 g. Juveniles (recruits) are rarely seen and Shelly (1981 - quoted in Preston, in press) did not find any juveniles of *H. scabra* less than 60 mm in length. Length-weight relationship for *H. scabra* has been calculated by Conand (1989) to be Log W = 2.28 Log L-6.35 (correlation coeficient=0.78) and Shelly (1981) $W = 3.06L^{1.61}$ (correlation coefficient=0.75) while that for *H. scabra* var *versicolor* is Log W=2.26 Log L-5.97 (correlation coefficient 0.76) (Conand, 1989). (L in cm and W in g).

***H. nobilis* (the "black teatfish") and *H. fuscogilva* (the "white teatfish"):**
Sexes are separate with a ratio of about 1:1. Reproduction is sexual. A five-stage maturity scale has been identified which is typical for the family Holothuriidae and details are given in Conand (1989). Male and females develop synchronously and for *H. nobilis*, spawning occurs during the cold months (June-August) while *H. fuscogilva* spawns in the warmer months (peaking in November-January). Spawning periods for these two species do not overlap. (Fission can be induced in *H. nobilis*). Absolute fecundity for *H. nobilis* was estimated to be between 13 and 78 million oocytes with *H. fuscogilva* recording lower fecundity of between 8 and 14 million oocytes per gram of ovary weight. Total weights at first sexual maturity were estimated to be 800 g and 1,175 g for *H. nobilis* and *H. fuscogilva* respectively. Juveniles are only rarely seen. Length-weight relationship was calculated by Conand (1989) for *H. nobilis* to be Log W=2.34 Log L-6.39 (correlation coefficeint=0.80) and for *H. fuscogilva* W=11.94 L-2712 (correlation coefficient=0.70). (L in cm and W in g).

A. echinites (*the "deep-water redfish*"):
Sexes are separate with a ratio of about 1:1. Spawning takes place during the warmer months (peak in January-February) with absolute fecundity ranging from 4 to 25 million oocytes. Drained weight at first sexual maturity is 75 g corresponding to total weight of 90 g and total length of 12 cm. Shelly (1985) estimated the growth parameters of this species in PNG to be; L_∞= 23 cm, K=0.78 with a monthly length increase of 0.60 to 0.9 cm corresponding to a monthly weight increase of 1 to 5 g. Conand (1988 - quoted in Preston, in press) gave estimates for growth and mortality parameters to be: L_∞=29.5 cm, K=0.09 and M=0.64. Length-frequency data for this species in New Caledonia showed the absence of animals less than 40 mm in length (Conand 1986, quoted in Preston, in press). Length-weight relationship was calculated as $W=0.68\ L^{2.00}$ (correlation coefficient =0.61) (Shelley, 1982, quoted in Preston, in press).

***A. miliaris* (the "blackfish"):**
Little is known about this species. Some observations on spawning in natural environment during February and early March on the Great Barrier Reef suggests that reproduction takes place in the hot season. Measurements of small specimen, in July 1982, weighing 5 to 30 g (3 to 9 cm) indicated their growth rates were approximately 1 cm (5 g) per month assuming these were spawned in February of the same year. The Length-weight relationship for this species was calculated by Conand (1989) to be $W=0.824 \times 10^3\ L^{2.441}$ (correlation coefficient=0.96).

***T. ananas* (the "prickly redfish"):**
Spawning occurs during the warmer months, probably from January to March. Fecundity is not high with absolute fecundity ranging from 2 to 7 million oocytes per gram of ovary weight. First

sexual maturity is reached at total length of 30 cm (total weight of 1,230 g and drained weight of 1,150 g). Conand (1988, quoted in Preston, in press) gave growth parameters for this species as; L_{∞}=66.3 cm, K=0.20, M=0.63 and Length interval=160-640. The species is long-lived, with a low mortality and high asymptotic length. In New Caledonia no animals were recorded with lengths less than 180 mm. Using growth and mortality estimates, Conand (1988, quoted in Preston, in press) estimated the biomass of theoretical cohorts of this species as it aged which enabled her to estimate the average length at which the biomass of the cohort is greatest and fishing will give the highest yields ("critical length"). The critical length was found to be 28 cm, slightly lower than the length at first sexual maturity. The length-weight relationship was calculated to be $W=1.27 \times 10^{-3} L^{2.441}$.

***H. atra* (the "lollyfish"):**
The lollyfish is the most common and abundant species on the tropical shore. Asexually reproduction through fission is thought to be very important in this species and the products of fission may comprise up to 70 percent of the population. Growth and Mortality parameters were estimated in Conand (1988-quoted in Preston, in press) as: L_{∞}= 324 mm, K=0.11, M=1.02 and Length interval=130-220. The length-weight relationship has been calculated to be Log W=2.13 Log - 5.64 (correlation coefficient=0.90).

***A. mauritiana* (the "surf redfish"):**
This species is widespread in the tropical Indo-Pacific region and its habitat is restricted to outer reef flats subject to strong waves and currents. Its diet is mainly of plant debris. Reproduction is sexual but fission can be induced in this species. Absolute fecundity was estimated to be between 22-33 million oocytes per gram ovary weight. The growth and mortality parameters have been calculated to be L_{∞} = 340, K=0.12, M=1.45, and length interval=70-280 (Conand, 1988, quoted in Preston, in press).

18.2 CORALS

18.2.1 The Resource

Species present

Veron (1990) gives comprehensive details of the results of the study conducted in 1988 by the Australian Institute of Marine Science (AIMS) on the hermatypic (reef-building) corals in Vanuatu. Hermatypic coral species listed as "very common" during the survey are given in the table below with some remarks made. No information is available on coral species exported from Vanuatu as "rocks".

Smith (1992) lists coral species sought for ornamental or curio purposes to include, branching corals (*Acropora*, *Seriatopora*, *Pocillopora*), stinging corals (*Millepora*, *Strylaster*), organpipe corals (*Tubipora*), brain corals (*Goniastrea*, *Euphyllia*) and mushroom corals (*Fungia*). Eight species of precious corals, *Corallium* sp. have been found at depths of 100m to 1,200m in Vanuatu waters (Eade, 1988, quoted in Wright, 1989).

Table 96 Species of corals found in Vanuatu

Species	Remarks	Species	Remarks
Pocillopora damicornis	wide range of habitat	*Porites latistella*	no taxonomic differences from Philippine's colonies
P. verrucosa	on upper reef slopes	*Goniopora somaliensis*	mostly on lower reef slopes and in lagoons
Seriatopora hystrix	on upper reef slope	*G. tenuidens*	on upper reef slopes and in shallow lagoons
Stylophora pistillata	in exposed shallow upper slopes	*G. minor*	protected reef slopes and in lagoons
Montipora capricornis	at 10-20m depth	*Coeloseris mayeri*	some exposed upper reef slopes and sometimes on lower slopes
M. caliculata	more polymorphic than observed on GBR	*Pachyseris rugosa*	forms very large colonies in some lagoons
M. samarensis	reef flats	*Fungia (Pleuractis) scutaria*	no taxonomic difference from GBR coralla
M. altasepta	on protected reef flats	*Galaxea fascicularis*	protected lower reef slopes and in lagoons
M. digitata	on reef flats, no taxonomic differences from in GBR	*Lobophyllia hemprichii*	on most reef slopes
M. hispida	forms large reddish-orange colonies	*Diploastrea heliopora*	abundant on exposed upper reef slopes
M. crassituberculata	in wide range of biotopes	*Cyphastrea serailia*	in a wide range of environments
Acropora palifera	on exposed upper reef slopes	*Echinopora lamellosa*	over wide range of environments
A. formosa	in most reef habitats	*E. mammiformis*	in one station where it forms monospecific stands. Less common elsewhere
A. echinata	in some lower reef slope stations and some lagoons and may form very extensive mono-specific stands		

Even though not well documented, Vanuatu has healthy populations of soft corals and common sponges. Sponges are primitive multicellular organisms. There are over 5000 species of sponges that have been described to date. In Vanuatu Research studies carried out by the Coral Reef Research Foundation in 2000 around Efate island and Espiritu Santo Island alone identified at least, 158 species of common sponges of the Phylum: *Porifera* and Class: *Demospongia*. As regards to soft coral, a total of at least 106 species were identified to belong to the Phylum: *Cnidaria*, Class: *Hyrozoa* and Class: *anthozoa*, Subclass:*Octocorallia*.

18.2.1.1 Distribution

Coral reefs are tropical, shallow water ecosystems, largely restricted to the area between the latitudes 30°N and 30°S (Sheppard and Wells, 1988). Generally vertical distribution of corals is determined by light and the actual depth limit depends on water transparency and no reefs develop in areas where annual minimum temperature is below 18°C (Achituv and Dubinsky, 1990).

Precious corals, *Corallium* sp. were found at depths of 100m to 1,200m in Vanuatu during the CCOP/SOPAC Precious Coral survey. Coral species utilized in the ornamental trade are those in the shallow reef areas.

18.2.1.2 Biology and ecology

Growth in coral is optimal only within a fairly narrow range of water temperature and salinities and thus varies considerably from area to area. Some *Acropora* grow fast (up to 20cm per year) while *Favia* and *Porites* grow very slowly (Lewis, 1985 and Veron, 1986). Achituv and Dubinsky (1990), notes that maximal growth usually occurs only down to 30-40% of subsurface irradiance (*the irradiance immediately below the water surface*) and rarely is any significant reef formation found below 10% irradiance. Reproduction is both sexual and asexual. Harrison and Wallace (1990), records that sexual reproduction patterns include hermaphroditic or gonochronic species with broadcast spawning or brooding modes of development. Hermaphroditic broadcast spawners being the dominant group.

Several asexual processes of reproduction can result in the formation of new colonies or solitary corals. These processes include fragmentation of established colonies, budding and transverse or longitudinal fission, single polyp bail-out, detachment of groups of polyps as drifting polyp balls and asexually produced planulae. Spawning has been observed mostly at night between dusk and mid-night.

Sponges are exclusively sessile animals with large goblet-shaped structures and are divided into three organizational types – asconoids, syconoids, and leuconoids. The simplest are the asconoids sponges. Asconoid sponges have but one large chamber or atrium lined with flagellated choanocytes. Because of their simple structure and organization, these sponges grow no larger than 8 mm. The second more advanced type of sponge is the syconoid sponge. Folds in the body wall give rise to cup-shaped structures called radial tubes. Sponges with this structure have a maximum length of 4 cm. The majority of sponges, icluding all large sponges, belong to the third group, the leuconoid sponges.

Sponges undergo sexual as well as asexual reproduction (budding). Gametes are not produced in particular organs, but throughout the body of the sponge. Most sponges are hermaphrodites. Sperm cells, which are released into the open wate, fertilize the amoeboid egg cells of conspecific sponges. Sponges have an exceptional capacity of regeneration. Small pieces can grow into new sponges. Even when several species of sponges are minced, scrapped, mixed, and pressed through a sieve, they regenerate into complete organisms. Sponges thrive in a variety of habitats, even in dark locations avoided by many animals, such as grottos, caves and overhangs. Their natural enemies include a few snails, nudibrachs, free-living worms, crustacea (crabs), fishes and turtles with diet centered on sponges.

18.2.2 The Fishery

18.2.2.1 Utilization

Corals are collected to a limited extent for the local tourist trade as well as for home decorations. Some are exported together with aquarium fish as "rocks". Crossland (undated) notes that the original concern over the wreck of the President Coolidge and Million Dollar Point that led to the establishment of the area as the first national marine reserve was that certain individuals were souveniring parts of the wreck and also stripping the area of corals, mainly the colourful gorgonians and the red *Distichopora violacea*. He further notes that some of the corals were being collected on a semi-commercial basis by local divers.

The demand for live corals for the Aquarium trade is huge. This led to the Department of Fisheries issuing licenses for cultured coral in 2000. In 2004 the Department of Fisheries revoked all licenses for export of live cultured corals on the basis that some exporters were practically removing live coral of the Acropora spp from the wild and exporting them as cultured corals. The Department of Fisheries however, allows exports of live “rocks” for the aquarium trade industry.

As regards to sponges, multiple chemical compounds have been isolated from sponges and are now synthesized worldwide. Antibiotics, hormones, and even some compounds able to halt the growth of certain types of tumors are among them.

18.2.2.2 Production and marketing

Marketed together with the aquarium fishes are pieces of coral marked as corals. Exported also for the aquarium industry is “live rock”. Records extracted from application forms for permits to export marine products from Vanuatu in 1992 showed that a total of 840 pieces of "rocks" worth VT30,600 were exported to New Zealand, United`States of America, and Japan.

Summarized in the tables below are the export figures coral and live rock for the years 1997 to the first half of 2004.

Table 97 Coral and live rock exports

	Coral		Live rock	
Year	**Pieces**	**VT**	**KG**	**VT**
1997	373	-	23,350	-
1998	722	-	15,370	-
1999	75	-	13,160	-
2000	4,013	-	23,630	1,596,839
2001	7,000	922,521	19,195	2,278,931
2002	780	328,474	26,950	3,734,349
2003	2,185	1,020,445	25,889	14,225,901
2004 (Jan-Jul)	Ban	-	36,600	3,355,300

Given the economic viability of the sponges, there has not been are exports of sponges overseas from Vanuatu. The Department of Fisheries does not issue permits for harvest of wild sponge populations for export purposes.

18.2.3 Stocks Status

One of the most recent surveys conducted on the corals and coral reefs in Vanuatu is that by AIMS in 1988. All information in this section is derived from results of that survey. Done and Navin (1990) observed that Vanuatu's reefs include pristine areas with no evidence of recent

physical damage, and others where there have been considerable recent death and injury to corals are attributed to cyclones, sea level changes and crown-of-thorns starfish. Outstanding coral reefs valuable for the tourist industry were observed on the east side of Inyeug on Aneityum, west side of Cook Reef, entrance to Hog Harbour on Lathu Island, reef slopes adjacent to the western bay on Reef Islands and on Ureparapara. Even though the status of reefs in Vanuatu was listed as "good" by Dahl (1985, quoted in Done and Navin, 1990) the situation was assessed "poor" in 1988 even with the exceptions of some areas as stated above. It was suggested that much of the degradation had taken place since 1985 mainly from cyclones and crown-of-thorns starfish.

In 1998, the Department of Fisheries initiated a Coral Reef Monitoring Progarm with funding support from theSouth West Pacific node at MSP, University of the South Pacific. A total of ten sites were selected to be regularly monitored, eight of which are located on Efate island, one site on Iapuna, Epi and another site on Aore island. Monitoring results showed that the main cause of stress to corals in Vanuatu, are from natural disasters (bleaching, cyclone damage and crown of thorn *Acanthaster planci*, predation). The most recent bleaching in 2000/2001 caused coral deaths around west Efate from Port Vila habour, Mele Bay and Erakor island. Coral bleaching was observed on all monitoring sites.

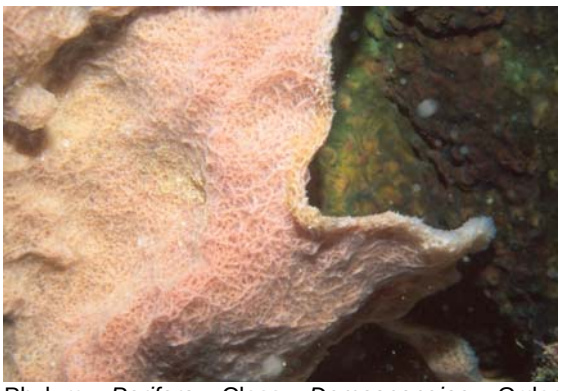
Coral gardens around Aore island and Million Dollar Point on Santo, were severely damaged due to predation by crown of thorns. This led the Department of Fisheries to initiate a crown of thorn eradication and awareness program for Aore island. A joinforce comprising Santo Fisheries Staff, the Vanuatu Moblie Force, Santo Dive operators, youths and village communities started a clean up campsign in May 2004 with funding support from the Biodiversity Project. In September 2004, a second clean up campaign was held with funding support from the Foundation of the People of the South Pacific (FSP). A total of 1,187 crown of thorns were eradicated. Damage by Crown of thorn predation is also recorded in Aneityum, Epi and Malekula reefs.

Cyclones have also played a vital role in damaging corals in Vanuatu. Cyclone Danny in 2003 damaged 80% of live corals on expose reefs on South West Efate from Malapoa, Devils Point, Pango, Hat island and Lelepa. Flooding of rivers and streams caused by cyclone Danny, also brought considerable amounts of silts and mud onto the coastal waters causing high mortality of corals.

Earthquakes also contribute to coral deaths in Vanuatu. In 1999, the northern part of Ambrym island was forced upward by an earthquake. This resulted in a 10.0 m Tsunami, which hit South Pentecost killing 11 people, injuring 50 others, displacing over 100 people and causing servere damage to the coral reefs.

There has not been any stock assessment surveys carried out to determine the status of stocks of sponges through out Vanuatu, nor has there been any comprehensive scientific assessment to document all species of sponges in Vanuatu waters. Pictures below show some of the common sponges found around Efate and Santo islands.

Phylum: *Porifera*; Class: *Demospongiae*; Order: *Astrophoridae*; Family: *Ancorinidae*; Genus: *Stelletta;* Species: *Splendens*



Phylum: *Porifera*; Class: *Demospongiae*; Order: *Haplosclerida*; Family: *Niphatidae*; Genus: *Dasychalina;* Species*: Callista*

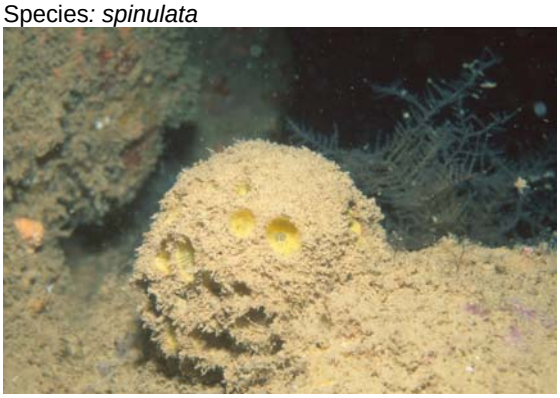
Phylum: *Porifera*; Class: *Demospongiae*; Order: *Homoscleromorphida*; Family: *Plakinidae*; Genus: *Plakortis;* Species*: not able to identify*

Phylum: *Porifera*; Class: *Demospongiae*; Order: *Halichondrida*; Family: *Axinellida*; Genus: *Axinella;* Species*: Carteri*

Phylum: *Porifera*; Class: *Demospongiae*; Order: *Hadromerida*; Family: *Alectonidae*; Genus: *Neamphius;* Species*: Huxleyi*

Phylum: *Porifera*; Class: *Demospongiae*; Order: *Halichondridae*; Family: *Dictyonellidae*; Genus: *Liosina;* Species*: Paradoxa*

Phylum: *Porifera*; Class: *Demospongiae*; Order: *Poecilosclerida*; Family: *Crellidae*; Genus: *Crella;* Species*: spinulata*



Phylum: *Porifera*; Class: *Demospongiae*; Order: *Spirophorida*; Family: *Tetillidae*; Genus: *Cinchyra;* Species*: New species*

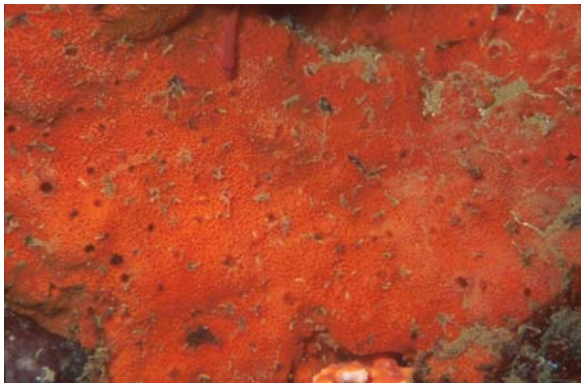
Phylum: *Porifera*; Class: *Demospongiae*; Order: *Halichondrida*; Family: *Dictyonellidae*; Genus: *Acanthella;* Species*: Not known*

Phylum: *Porifera*; Class: *Demospongiae*; Order: *Dictyoceratida*; Family: *Spongiidae*; Genus: *Coscinoderma;* Species*: methewsi*

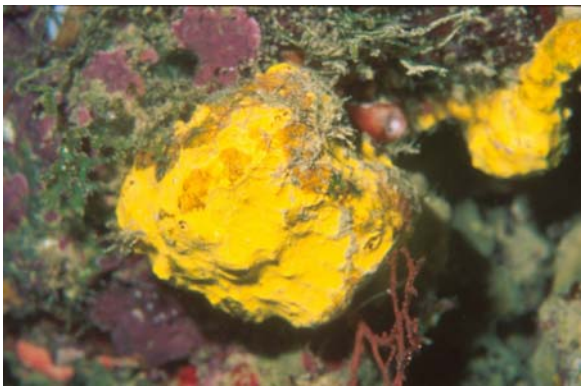
Phylum: *Porifera*; Class: *Demospongiae*; Order: *Halichondrida*; Family: *Dictyonellidae*; Genus: *Rhaphoxya;* Species*: typica*

Phylum: *Porifera*; Class: *Demospongiae*; Order: *Haploscleridae*; Family: *Petrosiidae*; Genus: *Petrosia;* Species*: Sphaeroidea*

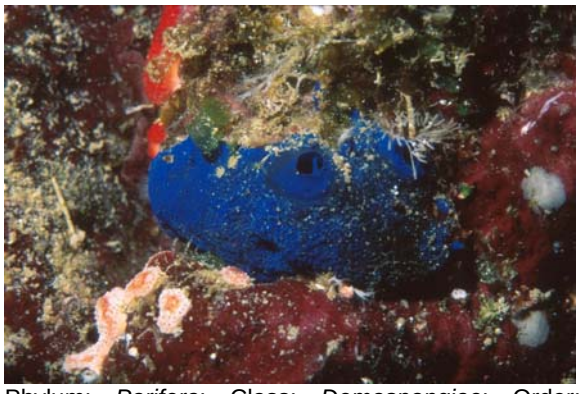
Phylum: *Porifera*; Class: *Demospongiae*; Order: *Spirophorida*; Family: *Tetillidae*; Genus: *Cinchyra;* Species*: not able to identify*



Phylum: *Porifera*; Class: *Demospongiae*; Order: *Halichondrida*; Family: *Axinellida*; Genus: *Gradmacidon;* Species*: australisy*



Phylum: *Porifera*; Class: *Demospongiae*; Order: *Verongida*; Family: *Aplysinellida*; Genus: *Suberea;* Species*: creba*



Phylum: *Porifera*; Class: *Demospongiae*; Order: *Halichondrida*; Family: *Halichondriidae*; Genus: *Axinyssa;* Species*:nat able to identify*

18.2.4 Management

Sheppard and Wells (1988) write "coral reefs rank as among the most biologically productive and diverse of all natural ecosystems, their high productivity stemming from efficient biological recycling, high retention of nutrients and a structure which provided habitat for a vast array of other organisms". Speaking of coral reefs evolution worldwide, Achituv and Dubinsky (1990) notes that corals reached their peak in the past, and at the present time they are in decline. Within Vanuatu, Done and Navin (1990) wrote that the major threats to existing healthy reefs, and to recovery of degraded reefs appear to be siltation which would accompany logging of steep watersheds, and eutrophication caused by domestic sewage discharged into reef waters. The greatest immediate threat to survival of corals however was attributed to continued crown-of-thorns starfish outbreaks.

Recent threats have been high seawater temperatures, which is the main cause of coral bleaching through out the archipelago. Exports of live coral for the aquarium trade can also be a threat if it is not monitored and managed strictly by the Fisheries Department.

18.2.4.1 Current legislation/policy regarding exploitation

Fisheries Regulation 19 prohibits the taking of more than 3 pieces of living coral in any period of 24 hours except with the permission of the Director and in accordance with such conditions as he may specify. In addition export of any coral is prohibited except with the written permission of the Director and in accordance with such conditions as he may specify.

18.2.4.2 Recommended legislation/policy regarding exploitation

Vanuatu is often affected by cyclones and their effects on coral reefs have been apparent in certain areas. The regulation on the taking and exporting of live corals may need to be reconsidered to limit collection to dead corals.

Even though the current level of exploitation of corals in Vanuatu does not seem to pose a threat to the resource, however it should be safeguarded now for future direction and development. Apart from total ban on harvesting and exportation, restriction options as already practised in other countries include some combinations of the following:

- licensing collectors
- imposition of quotas
- prohibition of the use of SCUBA
- restriction of species collected
- zonation of areas for collection
- restrict number of commercial operators

Appendix 5
Some of the Marine Sponges and soft corals found in water waters, especially around Efate and Santo.

Phylum	Class	Order	Family	Genus	Species
Porifera	Demospongiae	Astrophorida	Ancorinidae	Stelletta	splendens
Porifera	Demospongiae	Hadromerida	Alectonidae	Neamphius	huxleyi
Porifera	Demospongiae	Haplosclerida	Niphatidae	Dasychalina	callista
Porifera	Demospongiae	Halichondrida	Dictyonellidae	Liosina	paradoxa
Porifera	Demospongiae	Dictyoceratida	Spongiidae	Coscinoderma	mathewsi
Porifera	Demospongiae	Halichondrida	Halichondriidae	Axinyssa	topsenti
Porifera	Demospongiae	Halichondrida	Halichondriidae	Axinyssa	topsenti
Porifera	Demospongiae	Halichondrida	Dictyonellidae	Rhaphoxya	typica cf.
Porifera	Demospongiae	Dictyoceratida	Spongiidae	Coscinoderma	Not able to identify
Porifera	Demospongiae	Haplosclerida	Petrosiidae	Petrosid NG 1	Not able to identify
Porifera	Demospongiae	Poecilosclerida	Rhabderemiidae	Rhabderemia	sorokinae
Porifera	Demospongiae	Halichondrida	Halichondriidae	Topsentia	cavernosa
Porifera	Demospongiae	Dictyoceratida	Thorectidae	Thorectandra	Not able to identify
Porifera	Demospongiae	Halichondrida	Halichondriidae	Halichondria	tyleri cf.
Porifera	Demospongiae	'Lithistid'	Theonellidae	Theonella	Not able to identify
Rhodophyta	Demospongiae	Homoscleromorphida	Plakinidae	Plakortis	Not able to identify
Porifera	Rhodophyceae	Bonnemaisoniales	Bonnemaisoniaceae	Delisea	japonica
Porifera	Demospongiae	Haplosclerida	Petrosiidae	Petrosia (Strongylophora)	sphaeroidea
Chordata	Demospongiae	Dictyoceratida	Thorectidae	Carteriospongia	flabellifera
Chordata	Ascidiacea	Stolidobranchia	Styelidae	Polycarpa	rima
Porifera	Ascidiacea	Stolidobranchia	Styelidae	Polycarpa	cryptocarpa
Porifera	Demospongiae	Homoscleromorphida	Plakinidae	Corticium	niger cf.
Porifera	Demospongiae	Dictyoceratida	Thorectidae	Petrosaspongia	nigra
Porifera	Demospongiae	Halichondrida	Axinellidae	Axinella	carteri
Cnidaria	Demospongiae	Spirophorida	Tetillidae	Cinachyra	Not able to identify
Porifera	Anthozoa	Alcyonacea	Alcyoniidae	Sarcophyton	tortuosum
Cnidaria	Demospongiae	Spirophorida	Tetillidae	Cinachyra	Not able to identify
Porifera	Anthozoa	Zoanthidea	Zoanthidae	Palythoa	Not able to identify
Cnidaria	Demospongiae	'Lithistid'	Scleritodermidae	Microscleroderma	herdmani
Porifera	Anthozoa	Zoanthidea	Zoanthidae	Zoanthus	Not able to identify
Cnidaria	Demospongiae	Dictyoceratida	Spongiidae	Coscinoderma	Not able to identify
Porifera	Anthozoa	Alcyonacea	Nephtheidae	Dendronephthya	mucronata
Porifera	Demospongiae	Verongida	Aplysinellidae	Aplysinellid NG 1	Not able to identify
Porifera	Demospongiae	Halichondrida	Axinellidae	Cymbastela	cantherella
Porifera	Demospongiae	Dictyoceratida	Thorectidae	Taonura	mycofijiensis
Cnidaria	Demospongiae	Haplosclerida	Petrosiidae	Acanthostrongylophora	Not able to identify
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sarcophyton	Not able to identify
Porifera	Anthozoa	Alcyonacea	Alcyoniidae	Lobophytum	Not able to identify
Cnidaria	Calcarea	Clathrinida	Leucettidae	Leucetta	chagosensis
Chordata	Anthozoa	Alcyonacea	Clavulariidae	Clavularia	Not able to identify
Cnidaria	Ascidiacea	Phlebobranchia	Ascidiidae	Ascidia	ornata
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sinularia	Not able to identify
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sinularia	maxima
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sarcophyton	glaucum
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sinularia	mammifera
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sinularia	heterospiculata
Porifera	Anthozoa	Alcyonacea	Alcyoniidae	Klyxum	Not able to identify
Porifera	Demospongiae	Halichondrida	Axinellidae	Phakellia	cavernosa
Cnidaria	Demospongiae	Dictyoceratida	Dysideidae	Dysidea	frondosa
Porifera	Anthozoa	Alcyonacea	Alcyoniidae	Klyxum	Not able to identify
Porifera	Demospongiae	Astrophorida	Ancorinidae	Stelletta	clavosa
Mollusca	Demospongiae	Dictyoceratida	Dysideidae	Dysidea	avara"
Porifera	Gastropoda	Nudibranchia	Aegiridae	Notodoris	minor

Porifera	Demospongiae	Dictyoceratida	Thorectidae	Taonura	mycofijiensis
Porifera	Demospongiae	Halichondrida	Halichondriidae	Topsentia	cavernosa
Cnidaria	Demospongiae	Astrophorida	Thrombidae	Thrombus	Not able to identify
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sinularia	numerosa
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Lobophytum	Not able to identify
Porifera	Anthozoa	Alcyonacea	Alcyoniidae	Sinularia	Not able to identify
Porifera	Demospongiae	Chondrosida	Chondrillidae	Chondrosia	corticata
Porifera	Demospongiae	Haplosclerida	Petrosiidae	Xestospongia	Not able to identify
Porifera	Demospongiae	Haplosclerida	Callyspongiidae	Callyspongia (Euplacella)	Not able to identify
Porifera	Demospongiae	Agelasida	Agelasiidae	Agelas	Not able to identify
Porifera	Demospongiae	Halichondrida	Halichondriidae	Topsentia	Not able to identify
Cnidaria	Demospongiae	Haplosclerida	Petrosiidae	Xestospongia	Not able to identify
Porifera	Anthozoa	Alcyonacea	Alcyoniidae	Eleutherobia	Not able to identify
Cnidaria	Calcarea	Clathrinida	Leucettidae	Pericharax	heteroraphis
Porifera	Anthozoa	Alcyonacea	Nephtheidae	Dendronephthya	Not able to identify
Porifera	Demospongiae	Halichondrida	Dictyonellidae	Svenzea	Not able to identify
Cnidaria	Demospongiae	Halichondrida	Axinellidae	Dragmacidon	australis
Bryozoa	Anthozoa	Alcyonacea	Nephtheidae	Scleronephthya	Not able to identify
Porifera	Gymnolaemata	Cheilostomata	Phidoloporidae	Reteporella	cruciformis
Porifera	Demospongiae	Halichondrida	Desmoxyidae	Myrmekioderma	Not able to identify
Cnidaria	Demospongiae	Dictyoceratida	Thorectidae	Luffariella	variabilis
Porifera	Anthozoa	Alcyonacea	Alcyoniidae	Eleutherobia	Not able to identify
Cnidaria	Demospongiae	Halichondrida	Halichondriidae	Axinyssa	pseudo-Trachya
Cnidaria	Anthozoa	Alcyonacea	Nephtheidae	Scleronephthya	Not able to identify
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sinularia	abrupta
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sarcophyton	catalai
Rhodophyta	Anthozoa	Alcyonacea	Alcyoniidae	Sarcophyton	trocheliophorum
Chordata	Rhodophyceae	Gigartinales	Schizymeniaceae	Titanophora	weberae
Rhodophyta	Ascidiacea	Aplousobranchia	Polyclinidae	Pseudodistoma	digitata
Rhodophyta	Rhodophyceae	Bonnemaisoniales	Bonnemaisoniaceae	Delisea	Not able to identify
Porifera	Rhodophyceae	Nemaliales	Galaxauraceae	Galaxaura	fasciculata
Porifera	Demospongiae	Poecilosclerida	Raspailiidae	Eurypon	hispida
Porifera	Demospongiae	Dictyoceratida	Thorectidae	Hyrtios	erecta
Cnidaria	Demospongiae	Halichondrida	Dictyonellidae	Acanthella	Not able to identify
Porifera	Anthozoa	Actinaria	Actinodendronidae	Actinodendron	Not able to identify
Echinodermata	Demospongiae	Poecilosclerida	Desmacellidae	Biemna	fortis
Porifera	Asteroidea	Spinulosida	Echinasteridae	Echinaster	Not able to identify
Rhodophyta	Demospongiae	Hadromerida	Clionaidae	Spheciospongia	globularis
Echinodermata	Rhodophyceae	Corallinales	Corallinaceae	Amphiroa	fragilissima
Rhodophyta	Holothuroidea	Apodida	Synaptidae	Synaptula	Not able to identify
Echinodermata	Rhodophyceae	Gracilariales	Gracilariaceae	Gracilaria	salicornia
Rhodophyta	Echinoidea	Temnopleuroida	Temnopleuridae	Mespilia	globulus
Cyanophyta	Rhodophyceae	Ceramiales	Rhodomelaceae	Laurencia	palisada
Porifera	Cyanophyceae	Oscillatoriales	Phormidiaceae	Hydrocoleum	comoides
Porifera	Demospongiae	Haplosclerida	Petrosiidae	Xestospongia	exigua
Cnidaria	Demospongiae	Haplosclerida	Niphatidae	Gelliodes	Not able to identify
Porifera	Anthozoa	Alcyonacea	Gorgoniidae	Rumphella	Not able to identify
Cnidaria	Demospongiae	Halichondrida	Dictyonellidae	Stylissa	Not able to identify
Cnidaria	Anthozoa	Alcyonacea	Nephtheidae	Paralemnalia	Not able to identify
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sinularia	abrupta
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sinularia	numerosa
Porifera	Anthozoa	Alcyonacea	Alcyoniidae	Klyxum	Not able to identify
Porifera	Demospongiae	Haplosclerida	Niphatidae	Niphatid NG 2	Not able to identify
Porifera	Demospongiae	Verongida	Aplysinellidae	Aplysinellid NG 1	Not able to identify
Porifera	Demospongiae	Poecilosclerida	Acarnidae	Zyzzya	fuliginosa
Porifera	Demospongiae	Halichondrida	Halichondriidae	Halichondria	tyleri cf.
Cnidaria	Demospongiae	Poecilosclerida	Tedaniidae	Tedania	strongylostyla
Chordata	Anthozoa	Zoanthidea	Zoanthidae	Zoanthus	Not able to identify

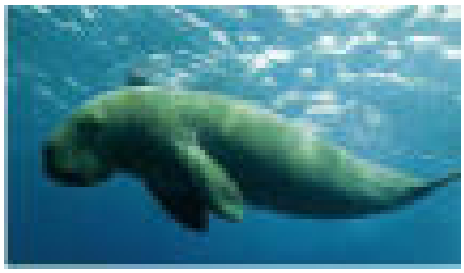
Chlorophyta	Ascidiacea	Aplousobranchia	Polycitoridae	Polyclinum	constellatum
Porifera	Chlorophyceae	Bryopsidales	Codiaceae	Codium	edule
Porifera	Demospongiae	Poecilosclerida	Crellidae	Crella	spinulata
Cnidaria	Demospongiae	Dictyoceratida	Dysideidae	Dysidea	rhax
Echinodermata	Anthozoa	Actinaria	Actiniidae	Entacmaea	Not able to identify
Cnidaria	Asteroidea	Spinulosida	Echinasteridae	Echinaster	luzonicus
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sinularia	frondosa
Cyanophyta	Anthozoa	Alcyonacea	Alcyoniidae	Sinularia	querciformis
Cnidaria	Cyanophyceae	Oscillatoriales	Schizotrichaceae	Schizothrix	calcicola
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Lobophytum	Not able to identify
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Lobophytum	Not able to identify
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Lobophytum	crassum
Chordata	Anthozoa	Alcyonacea	Alcyoniidae	Dampia	pocilloporaeformis
Cnidaria	Ascidiacea	Aplousobranchia	Polycitoridae	Aplidium	Not able to identify
Chordata	Anthozoa	Alcyonacea	Briareidae	Briareum	Not able to identify
Porifera	Ascidiacea	Aplousobranchia	Polycitoridae	Cystodytes	fuscus
Porifera	Demospongiae	Halichondrida	Halichondriidae	Axinyssa	Not able to identify
Porifera	Demospongiae	Poecilosclerida	Isodictyidae	Coelocarteria	singaporense
Cyanophyta	Demospongiae	Haplosclerida	Petrosiidae	Petrosid NG	Not able to identify
Cnidaria	Cyanophyceae	Oscillatoriales	Schizotrichaceae	Schizothrix	calcicola
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sarcophyton	Not able to identify
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sarcophyton	trocheliophorum
Porifera	Anthozoa	Alcyonacea	Briareidae	Briareum	violacea
Porifera	Demospongiae	Dictyoceratida	Dysideidae	Dysidea	herbacea
Porifera	Demospongiae	Halichondrida	Dictyonellidae	Acanthella	Not able to identify
Porifera	Demospongiae	Dictyoceratida	Thorectidae	Carteriospongia	flabellifera
Porifera	Demospongiae	Dictyoceratida	Thorectidae	Hyrtios	reticulata
Porifera	Demospongiae	Dictyoceratida	Thorectidae	Dactylospongia	Not able to identify
Porifera	Demospongiae	Dictyoceratida	Irciniidae	Sarcotragus	Not able to identify
Porifera	Demospongiae	Verongida	Pseudoceratinidae	Pseudoceratina	arabica
Porifera	Demospongiae	Homoscleromorphida	Plakinidae	Plakortis	lita
Porifera	Demospongiae	Spirophorida	Tetillidae	Cinachyra	Not able to identify
Porifera	Demospongiae	Dictyoceratida	Spongiidae	Spongia	matamata
Cnidaria	Demospongiae	Halichondrida	Dictyonellidae	Svenzea	Not able to identify
Porifera	Anthozoa	Alcyonacea	Alcyoniidae	Sinularia	Not able to identify
Porifera	Demospongiae	Halichondrida	Halichondriidae	Halichondria	carbonaria" (Pellina)
Porifera	Demospongiae	Astrophorida	Ancorinidae	Stelletta	siemensi
Bryozoa	Demospongiae	Poecilosclerida	Mycalidae	Mycale (Aegogropila)	Not able to identify
Porifera	Gymnolaemata	Cheilostomata	Savignyellidae	Savignyella	lafontii
Porifera	Demospongiae	Hadromerida	Tethyidae	Tethya	robusta
Chordata	Demospongiae	Halichondrida	Halichondriidae		Not able to identify
Porifera	Ascidiacea	Stolidobranchia	Polyzoidae	Polyandrocarpa	Not able to identify
Chordata	Demospongiae	Poecilosclerida	Myxillidae	Myxilla (Myxilla)	Not able to identify
Cnidaria	Ascidiacea	Stolidobranchia	Pyuridae	Herdmania	Not able to identify
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Klyxum	Not able to identify
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sarcophyton	tortuosum
Porifera	Anthozoa	Alcyonacea	Alcyoniidae	Sarcophyton	glaucum
Cnidaria	Demospongiae	Dictyoceratida	Thorectidae	Petrosaspongia	nigra
Cnidaria	Anthozoa	Alcyonacea	Acanthogorgiidae	Acanthogorgia	Not able to identify
Cnidaria	Anthozoa	Alcyonacea	Nidaliidae	Siphonogorgia	Not able to identify
Cnidaria	Anthozoa	Alcyonacea	Briareidae	Briareum	violacea
Cnidaria	Anthozoa	Alcyonacea	Nidaliidae	Siphonogorgia	Not able to identify
Cnidaria	Anthozoa	Alcyonacea	Nidaliidae	Siphonogorgia	Not able to identify
Echinodermata	Anthozoa	Alcyonacea	Nidaliidae	Siphonogorgia	Not able to identify
Cnidaria	Crinoidea	Comatulida	Himerometridae	Himerometra	magnipinna
Porifera	Anthozoa	Zoanthidea	Epizoanthidae	Epizoanthus	Not able to identify
Cnidaria	Demospongiae	Halichondrida	Halichondriidae	Axinyssa	topsenti
Cnidaria	Anthozoa	Alcyonacea	Melithaeidae	Melithaea	Not able to identify
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sarcophyton	Not able to identify

Porifera	Anthozoa	Alcyonacea	Nidaliidae	Siphonogorgia	Not able to identify
Cnidaria	Demospongiae	Homoscleromorphida	Plakinidae	Plakortis	Not able to identify
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sinularia	flexibilis
Porifera	Anthozoa	Alcyonacea	Clavulariidae	Clavularia	sp. g
Porifera	Demospongiae	Haplosclerida	Chalinidae	Haliclona	Not able to identify
Porifera	Demospongiae	Haplosclerida	Chalinidae	Haliclona	Not able to identify
Porifera	Demospongiae	Dictyoceratida	Thorectidae	Hyrtios	Not able to identify
Cnidaria	Demospongiae	Dictyoceratida	Spongiidae	Spongia	Not able to identify
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Cladiella	Not able to identify
Porifera	Anthozoa	Alcyonacea	Alcyoniidae	Cladiella	humesi
Porifera	Demospongiae	Astrophorida	Ancorinidae	Stelletta	splendens
Porifera	Demospongiae	Poecilosclerida	Crellidae	Crella	spinulata
Porifera	Demospongiae	Haplosclerida	Niphatidae	Gelliodes	fibulata
Porifera	Demospongiae	Dictyoceratida	Thorectidae	Carteriospongia	flabellifera
Porifera	Demospongiae	Dictyoceratida	Thorectidae	Petrosaspongia	niger
Porifera	Demospongiae	Spirophorida	Tetillidae	Cinachyra	Not able to identify
Porifera	Demospongiae	Dictyoceratida	Spongiidae	Spongia	australis cf.
Porifera	Demospongiae	Halichondrida	Axinellidae	Dragmacidon	australis
Porifera	Demospongiae	Haplosclerida	Petrosiidae	Petrosia (Strongylophora)	Not able to identify
Porifera	Demospongiae	Dictyoceratida	Dysideidae	Dysidea	frondosa cf.
Porifera	Demospongiae	Halichondrida	Dictyonellidae	Stylissa	Not able to identify
Porifera	Demospongiae	Dictyoceratida	Spongiidae	Coscinoderma	mathewsi cf.
Porifera	Demospongiae	Haplosclerida	Chalinidae	Haliclona (Gellius)	flagellifer cf.
Porifera	Demospongiae	Halichondrida	Axinellidae	Axinella	carteri
Cnidaria	Demospongiae	Halichondrida	Dictyonellidae	Liosina	paradoxa
Porifera	Hydrozoa	Hydroida	Stylasteridae	Distichopora	Not able to identify
Porifera	Demospongiae	Haplosclerida	Niphatidae	Dasychalina	callista
Chordata	Demospongiae	Haplosclerida	Callyspongiidae	Callyspongia (Cavochalina)	bilamellata cf.
Porifera	Ascidiacea	Aplousobranchia	Polycitoridae	Cystodytes	fuscus?
Chlorophyta	Demospongiae	Halichondrida	Halichondriidae	Topsentia	halichondroides cf.
Porifera	Chlorophyceae	Bryopsidales	Halimedaceae	Halimeda	cylindracea
Porifera	Demospongiae	Homoscleromorphida	Plakinidae	Corticium	niger cf.
Porifera	Demospongiae	Dictyoceratida	Thorectidae	Cacospongia	Not able to identify
Porifera	Demospongiae	Dictyoceratida	Irciniidae	Psammocinia	Not able to identify
Porifera	Demospongiae	Poecilosclerida	Acarnidae	Zyzzya	fuliginosa
Porifera	Demospongiae	Halichondrida	Halichondriidae	Axinyssa	topsenti
Bryozoa	Demospongiae	Poecilosclerida	Crellidae	Crella (Grayella)	papillata
Porifera	Gymnolaemata	Cheilostomata	Phidoloporidae	Reteporella	cruciformis
Porifera	Demospongiae	Dictyoceratida	Thorectidae	Hyrtios	erecta
Porifera	Demospongiae	Chondrosida	Chondrillidae	Chondrosia	corticata
Porifera	Demospongiae	'Lithistid'	Theonellidae	Placinolopha'	mirabilis
Porifera	Demospongiae	Halichondrida	Axinellidae	Cymbastela	cantherella
Porifera	Demospongiae	Haplosclerida	Phloeodictyidae	Oceanapid NG 1	Not able to identify
Porifera	Demospongiae	Halichondrida	Halichondriidae	Axinyssa	topsenti
Porifera	Demospongiae	Halichondrida	Halichondriidae	Axinyssa	terpnis
Porifera	Demospongiae	Dictyoceratida	Thorectidae	Luffariella	Not able to identify
Porifera	Demospongiae	Haplosclerida	Petrosiidae	Xestospongia	Not able to identify
Porifera	Demospongiae	Verongida	Pseudoceratinidae	Pseudoceratina	Not able to identify
Porifera	Demospongiae	Hadromerida	Clionaidae	Spheciospongia	vagabunda var. olive gold
Porifera	Demospongiae	Dictyoceratida	Thorectidae	Dactylospongia	metachromia
Porifera	Demospongiae	Dendroceratida	Dictyodendrillidae	Acanthodendrilla	australis
Chordata	Demospongiae	Dictyoceratida	Dysideidae	Dysidea	rhax
Porifera	Ascidiacea	Aplousobranchia	Didemnidae	Polysyncraton	pavimentum
Cnidaria	Demospongiae	Haplosclerida	Chalinidae	Haliclona	Not able to identify
Porifera	Hydrozoa	Leptothecatae	Aglaopheniidae	Aglaophenia	cupressina
Porifera	Demospongiae	Dictyoceratida	Thorectidae	Dactylospongia	Not able to identify

Cnidaria	Demospongiae	Poecilosclerida	Isodictyidae	Coelocarteria	singaporense
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sarcophyton	Not able to identify
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sarcophyton	Not able to identify
Chordata	Anthozoa	Alcyonacea	Nephtheidae	Nephthea	Not able to identify
Chordata	Ascidiacea	Aplousobranchia	Polycitoridae	Eudistoma	atrum?
Porifera	Ascidiacea	Aplousobranchia	Polyclinidae	Pseudodistoma	fragilis
Cnidaria	Demospongiae	Haplosclerida	Chalinidae	Haliclona (Haliclona)	(Adocia)
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sarcophyton	glaucum
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sinularia	flexibilis
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sinularia	scabra cf.
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sinularia	Not able to identify
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sinularia	Not able to identify
Porifera	Anthozoa	Alcyonacea	Alcyoniidae	Lobophytum	cryptocorum
Porifera	Demospongiae	Halichondrida	Dictyonellidae	Liosina	paradoxa
Porifera	Demospongiae	Dictyoceratida	Thorectidae	Carteriospongia	flabellifera
Porifera	Demospongiae	Dictyoceratida	Irciniidae	Psammocinia	Not able to identify
Porifera	Demospongiae	Haplosclerida	Phloeodictyidae	Oceanapid NG 1	Not able to identify
Porifera	Demospongiae	Verongida	Aplysinellidae	Suberea	creba
Cnidaria	Demospongiae	Poecilosclerida	Podospongiidae	Diacarnus	levii cf.
Porifera	Anthozoa	Alcyonacea	Alcyoniidae	Sinularia	flexibilis
Cnidaria	Demospongiae	Hadromerida	Alectonidae	Neamphius	huxleyi
Porifera	Anthozoa	Alcyonacea	Alcyoniidae	Sinularia	Not able to identify
Cnidaria	Demospongiae	Haplosclerida	Petrosiidae	Petrosia (Strongylophora)	Not able to identify
Cnidaria	Anthozoa	Alcyonacea	Nephtheidae	Nephthea	Not able to identify
Porifera	Anthozoa	Alcyonacea	Alcyoniidae	Sinularia	gardineri cf.
Cnidaria	Demospongiae	Haplosclerida	Chalinidae	Haliclona	osiris
Cnidaria	Anthozoa	Alcyonacea	Nephtheidae	Paralemnalia	Not able to identify
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sinularia	flexibilis
Porifera	Anthozoa	Alcyonacea	Clavulariidae	Clavularia	Not able to identify
Porifera	Demospongiae	Poecilosclerida	Acarnidae	Zyzzya	fuliginosa
Porifera	Demospongiae	Halichondrida	Halichondriidae	Topsentia	stalagmites cf.
Cnidaria	Demospongiae	Dictyoceratida	Thorectidae	Fascaplysinopsis	Not able to identify
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Cladiella	Not able to identify
Chlorophyta	Anthozoa	Alcyonacea	Nephtheidae	Dendronephthya	Not able to identify
Porifera	Chlorophyceae	Bryopsidales	Caulerpaceae	Caulerpa	racemosa
Cnidaria	Demospongiae	Halichondrida	Halichondriidae	Topsentia	Not able to identify
Porifera	Hydrozoa	Hydroida	Stylasteridae	Distichopora	violacea
Chordata	Demospongiae	Dictyoceratida	Spongiidae	Leiosella	ramosa
Porifera	Ascidiacea	Aplousobranchia	Polycitoridae	Eudistoma	vulgare
Porifera	Demospongiae	Haplosclerida	Chalinidae	Haliclona (Haliclona)	Not able to identify
Porifera	Demospongiae	Poecilosclerida	Mycalidae	Mycale (Aegogropila)	Not able to identify
Porifera	Demospongiae	Agelasida	Agelasiidae	Agelas	Not able to identify
Porifera	Demospongiae	Dendroceratida	Darwinellidae	Dendrilla	Not able to identify
Chordata	Demospongiae	Dictyoceratida	Dysideidae	Dysidea	nigrescens cf.
Chordata	Ascidiacea	Aplousobranchia	Polycitoridae	Aplidium	Not able to identify
Cnidaria	Ascidiacea	Aplousobranchia	Polycitoridae	Cystodytes	Not able to identify
Porifera	Anthozoa	Zoanthidea	Zoanthidae	Palythoa	Not able to identify
Porifera	Demospongiae	Haplosclerida	Petrosiidae	Petrosid NG 3	Not able to identify
Cnidaria	Demospongiae	Spirophorida	Tetillidae	Cinachyra	Not able to identify
Porifera	Anthozoa	Alcyonacea	Alcyoniidae	Sinularia	Not able to identify
Porifera	Demospongiae	Halichondrida	Halichondriidae	Topsentia	halichondrioides
Porifera	Demospongiae	Astrophorida	Ancorinidae	Rhabdastrella	globostellata
Porifera	Demospongiae	Agelasida	Agelasiidae	Agelas	mauritiana var. oxeata
Porifera	Demospongiae	Halichondrida	Halichondriidae	Axinyssa	topsenti
Cnidaria	Demospongiae	Halichondrida	Halichondriidae	Topsentia	cavernosa cf.
Porifera	Anthozoa	Alcyonacea	Alcyoniidae	Lobophytum	crassum
Porifera	Demospongiae	Haplosclerida	Chalinidae	Haliclona	Not able to identify

Cnidaria	Calcarea	Clathrinida	Leucettidae	Leucetta	chagosensis
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sinularia	halversoni cf.
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sarcophyton	Not able to identify
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sinularia	Not able to identify
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sinularia	variabilis cf.
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sinularia	Not able to identify
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sarcophyton	tortuosum
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Lobophytum	Not able to identify
Cnidaria	Anthozoa	Alcyonacea	Alcyoniidae	Sinularia	rigida cf.
Porifera	Anthozoa	Alcyonacea	Briareidae	Briareum	violacea
Cnidaria	Demospongiae	Dictyoceratida	Dysideidae	Dysidea	nigrescens cf.
Porifera	Anthozoa	Alcyonacea	Nephtheidae	Nephthea	Not able to identify
Echinodermata	Demospongiae	Dictyoceratida	Thorectidae	Petrosaspongia	nigra
Rhodophyta	Holothuroidea	Aspidochirotida	Stichopodidae	Stichopus	pseudhorrens
Chordata	Rhodophyceae	Bonnemaisoniales	Bonnemaisoniaceae	Delisea	Not able to identify
Porifera	Ascidiacea	Aplousobranchia	Polycitoridae	Aplidium	caelestis
Cnidaria	Demospongiae	Dictyoceratida	Dysideidae	Dysidea	Not able to identify
Porifera	Anthozoa	Alcyonacea	Melithaeidae	Melithaea	Not able to identify
Cnidaria	Demospongiae	Halichondrida	Axinellidae	Ptilocaulis	spiculifer
Porifera	Anthozoa	Zoanthidea	Zoanthidae	Palythoa	Not able to identify
Porifera	Demospongiae	Agelasida	Agelasiidae	Agelas	Not able to identify
Cnidaria	Demospongiae	Haplosclerida	Callyspongiidae	Callyspongia	Not able to identify
Rhodophyta	Anthozoa	Alcyonacea	Nephtheidae	Dendronephthya	mucronata
Cnidaria	Rhodophyceae	Plocamiales	Plocamiaceae	Plocamium	telfairiae
Chlorophyta	Anthozoa	Alcyonacea	Acanthogorgiidae	Acanthogorgia	Not able to identify
Cyanophyta	Chlorophyceae	Bryopsidales	Bryopsidaceae	Bryopsis	pennata subsecunda
Porifera	Cyanophyceae	Oscillatoriales	Phormidiaceae	Phormidium	penicillatum
Porifera	Calcarea	Clathrinida	Leucettidae	Leucetta	chagosensis
Chordata	Demospongiae	Haplosclerida	Callyspongiidae	Callyspongia	aerizusa
Cnidaria	Ascidiacea	Aplousobranchia	Polycitoridae	Cystodytes	violatinctus
Cnidaria	Anthozoa	Alcyonacea	Acanthogorgiidae	Acanthogorgia	Not able to identify
Porifera	Anthozoa	Corallimorpharia	Actinodiscidae	Discosoma	Not able to identify
Cnidaria	Demospongiae	Homoscleromorphida	Plakinidae	Plakortis	Not able to identify
Cyanophyta	Anthozoa	Alcyonacea	Nidaliidae	Siphonogorgia	Not able to identify
Cnidaria	Cyanophyceae	Oscillatoriales	Phormidiaceae	Symploca	hydnoides
Cnidaria	Anthozoa	Alcyonacea	Anthothelidae	Alertigorgia	Not able to identify
Cnidaria	Anthozoa	Alcyonacea	Nidaliidae	Siphonogorgia	Not able to identify
Cnidaria	Anthozoa	Alcyonacea	Anthothelidae	Alertigorgia	Not able to identify
Porifera	Anthozoa	Alcyonacea	Nidaliidae	Siphonogorgia	Not able to identify
Porifera	Demospongiae	Halichondrida	Halichondriidae	Axinyssa	Not able to identify

18.3 DUGONGS



18.3.1 The Resource

Species present
Dugong dugon

18.3.1.1 Distribution

Dugongs are widely distributed in shallow, coastal tropical and sub-tropical waters from east Africa to the southwest Pacific. In the Pacific region, they are present in large numbers in some parts of Papua New Guinea (Hudson, 1977), New Caledonia and the Solomon Islands (Nishiwaki and Marsh, 1985), Yap and Guam (Nishiwaki *et al*, 1979), and Palau (Brownell, *et al* 1981). Large populations of dugongs, perhaps the most numerous remaining in the world, are found in Australia (Anderson, 1986; Heinsohn *et al* 1978; Marsh, 1986; Prince *et al* 1981). The Vanuatu archipelago forms the easternmost limit of the dugong's distribution (Marsh, 1983) where their populations are distributed throughout the islands from Aneityum in the south to the Torres Islands in the north of the archipelago (Chambers, *et al* 1989).

18.3.1.2 Biology and ecology

Distantly related to the elephant, the dugong (*D. dugon*) is a massive but inoffensive herbivorous mammal that is restricted to the sea. It is the only existing member of the family Dugongidae (Order Sirenia). The only other member of this family, Steller's sea cow, was hunted to extinction within 30 years of its discovery in the 18th century.

Dugongs tend to occur in warm, shallow, sheltered inshore and reef areas where beds of seagrasses occur. Analysis of the stomach contents indicate that they consume a wide variety of tropical and subtropical seagrasses preferring to feed on small delicate seagrasses and dig up the whole plant including the rhizomes, making a distinctive feeding trial. Algae are also eaten.

On a recent survey of coral reefs in Vanuatu, Chambers (1990) found nine species of seagrass, all of which are reported by Nishiwaki and Marsh (1985) to be eaten by dugongs. These seagrasses include *Cymodocea rotundata*, *C. serrulata*, *Enchalus acoroides*, *Halodule pinifolia*, *H. uninervis*, *Halophila ovalis*, *Syringodium isoetifolium*, *Thalassia hemprichii* and *Thalassodendron ciliatum*.

Dugongs have a potential life span of 60-70 years (Marsh and Naika, 1983). Females bear their first calf at a minimum age of 10 years (but sometimes not until 15-18 years) after a pregnancy lasting about a year. A single calf is usually born. Although a calf begins to eat seagrasses soon after birth, it can suckle for up to 2 years and the cow-calf bond seems to be extremely well-developed. Estimate of the average interval birth rates between calves for various Australian populations range from approximately 3-7 years.

Because dugongs are such slow breeders, mortality must also be very low for a dugong population to be maintained. By analogy with other wild mammals, mortality is expected to be higher in juveniles than in adults. Adult survivorship therefore needs to be very high (of the order of 95% per year or more) for population maintenance. Thus, dugongs are extremely susceptible to over-exploitation which is obviously why their status is now so vulnerable.

18.3.2 The Fishery

18.3.2.1 Utilization

Dugongs appear to be killed mainly as a source of protein. In Vanuatu they are hunted solely for food, with oil being a subsidiary reason (Chambers *et al* 1989). The flesh is taken mainly for subsistence purposes, and occasionally for ceremonial reasons. In other Pacific countries, for example, Papua New Guinea, dugongs are used to supply teeth for ornaments and jewellery, bones for utensils, spears and clubs, skin for earrings and amulets, and the skull and whiskers for display in the men's meeting house in some regions.

In most localities in Vanuatu where dugongs are killed, hunting can take place at any time of the year, and is not apparently governed by any custom or tradition. Where such controls do operate, they are mostly related to the yam seasons, which are events of great significance in Vanuatu. Many localities within Vanuatu do not consider the dugong an important animal either in terms of food or culture.

A survey on the status of the dugongs in Vanuatu by Chambers, Bani and Barker-Hudson in 1989 indicated that dugongs are killed by a variety of methods, but the common method is by spearing.

Table 98 Identified relative usage of methods by which dugongs are reportedly killed in Vanuatu (Chambers *et al* 1989).

Method	Number of people reporting this method
Spear	30
Blocking the nostrils	6
Setting nets	5
Gun	5
Dynamite	2
Axe	2
Accident - nets	2
Accident - Boats	1
Stone wall	1
Spear gun	1
Knife	1

Many people mentioned that dugongs were often caught in shallow water, particularly when stranded in pools by the receding tide.

Dugongs have recently become a major tourist attraction in Vanuatu, due to their behavior which makes them easy to be tamed. Reports have been received from islands in the archipelago of coastal communities feeding dugongs and swimining with the dugongs. In Epi (Lamen Bay) and Tanna (Port Resolution) tourists have the opportunity to be able to swim around with playful dugongs.

18.3.2.2 Production and marketing

There are no production records as well as records of dugong flesh being sold in the markets in Vanuatu. In Papua New Guinea the meat is freely marketed in some areas (Hudson 1977). In New Caledonia, dugong tusks are sold at US$60 each (Chambers, personal observation, 1988).

18.3.3 Stocks Status

Dugong numbers have greatly reduced in the recent past and in many areas it is now extinct or greatly reduced in numbers. Declines have been caused by overhunting, accidental mortality from boats and fishing nets, pollution and loss of the seagrass beds which provide its stable food (Chambers *et al* 1989).

In Micronesia (Yap, Guam and Palau) dugongs are rare and must be considered in danger of extinction. In Melanesia (PNG, Solomon Islands, New Caledonia and Vanuatu) dugong numbers have decreased in recent years and the long-term prospects of the dugong in Papua New Guinea must be considered as uncertain unless the hunting rate is reduced (Chambers *et al*, 1989). In New Caledonia and Solomon Islands the status of the dugong is not known, but it is hunted in both countries.

So far as is known at present, Vanuatu has the Pacific region's only reasonable dugong numbers that are not subjected to any great pressures that could lead to a marked decline in their numbers although it is not possible to make an accurate estimate of their numbers in Vanuatu. The survey conducted by Chambers, Bani and Barker-Hudson in 1989 indicated that dugongs are reported to be present in nearly all the 100 localities in the survey areas. Some major islands, where dugongs have been reported from many of their local localities, include Efate, Santo and Malekula. Other islands such as Tanna and Erromango had a few localities where they have been reported from. Most of the dugongs sighted were of single or pairs of animals with an average number reported from each locality of about 2 or 3.

Three islands were reported to have no dugongs. They are Futuna, Buninga and Mere Lava. In addition, dugongs were reportedly absent from the Dillon's Bay area of west coast Erromango and Wusi on west coast Santo.

18.3.4 Management

18.3.4.1 Current legislation/policy regarding exploitation:

Throughout its range, dugongs are considered an endangered species (IUCN,1982). In many countries the dugong is legally protected.

In Vanuatu, the dugong is protected by the Fisheries Act of 1982, which prohibits the capture of mammals in its waters.

18.3.4.2 Recommended legislation/policy regarding exploitation

Existing regulations seem to be adequate.

19 ENDEMIC FRESH WATER RESOURCES

This section covers both the edible and non edible fresh water fish and crustaceans of Vanuatu. Much of the information is obtained from Leah T. Nimoho's report on the Freshwater fish and crustaceans of Vanuatu. A report published by the Environment Unit in June of 2000.

19.1 Freshwater Ecosystems

The Freshwater ecosystems of Vanuatu comprises, rivers, streams, volcanic lakes, ephemeral lakes and swamps. The distribution of the various components of the freshwater ecosystems is patchy throughout the archipelago, covering only 1.0% of the total land area of approximately 14,763 square kilometers.

Freshwater ecosystems on larger islands of the Vanuatu archipelago, for example, the Jordan river on Santo; Cooks bay river on Erromango island; and Pankumo river on Malekula island have larger discharges which forms cascades, rockfaces, pools, tidal reaches and are often characterized as having extensive foold plans. Smaller islands ecosystems on the other hand only are often characterized by the presence of streams which are often ephemeral.

19.1.1 Importance of Freshwater Ecosystems

Freahwater and their ecosystems play an important role in the livelihood of basically every Ni-Vanuatu, particularly those inhabiting land areas in close proximity to freshwater systems. Rivers, stream and lakes provide a supply of water for the day to day living of a rural community, and for irrigation of land to grow staple root crops; a habitat where important sources of protein can be harvested, for example fish, eelfish, birds and invertebrates. These ecosystems also provide important habitats for diverse terrestrial wildlife including birds, invertebrates, fish, reptiles and frogs.

19.1.2 Freshwater Fauna Comosition

Dominant freshwater fauna of Vanuatu are fish, gastropods and crustaceans. Leah T. Nimoho (2000) reported 62 fish species under 20 Families, 7 species of prawns, which are all under one Family and 1 crab species.

Photographs below are typical freshwater ecosystems found in Vanuatu.

19.2 FAMILY: CARCHARHIDAE

19.2.1 The Resource

Species present
Carcharhinus leucas (Bull shark)

19.2.1.1 Distribution

The Bull Shark has also been called the River Shark, Freshwater Whaler, Estuary Whaler and Swan River Whaler. The Bull Shark can live in a wide range of habitats from coastal marine and estuarine, to freshwater.

It has been recorded from the surf zone down to a depth of at least 150m. It is the only species of shark that is known to stay for extended periods in fresh water. It has been reported nearly 4000km from the sea in the Amazon River system, and is known to breed in Lake Nicaragua, Central America. The Bull shark is common in Papua New Guinea and has been reported to inhabit inland river systems 130.0 kilometer from the marine coast. In Australia the Bull Shark occurs from Perth, Western Australia, around the northern coastline and down the east coast to Sydney, New South Wales. This species has a widespread distribution in tropical and warm temperate waters of the world. In Vanuatu Bull sharks have been reported within upper reaches of the Pankumo River, which is the largest river on Malekula Island.

19.2.1.2 Biology and ecology

The Bull Shark can be recognised by a combination of characters including a stout body, short blunt snout, triangular serrated teeth in the upper jaw and no fin markings as an adult. This species has a second dorsal fin about one third the height of the first, a small eye, and no skin ridge between the two dorsal fins. It is grey above and pale below, sometimes with a pale stripe on the flank.

The Bull Shark is a large species which grows to a length of 3.4m. It has an omnivorous diet which includes fishes (including other sharks), dolphins, turtles, birds, molluscs, echinoderms and even terrestrial mammals.

Whole shark

Head of the Bull Shark.

The lower two images show the **claspers** of the male shark. The claspers are located between the pelvic fins and are used for sperm transfer to the female. The hand at the left of the lower image has pulled open the folded tissue which forms the groove down which sperm passes during reproduction. The right hand has opened the tip of the clasper.

The two claspers of the male shark.

This is an aggressive species that is considered dangerous to humans. Some authors consider that the Bull Shark may be more dangerous than the Great White Shark and the Tiger Shark.

This is because of the Bull Shark's omnivorous diet and habitat preferences. This species may be found in murky water, where the splashing of a swimmer could be mistaken for a struggling fish. Bull sharks are heavily-bodied, short and have a broadly rounded snout. Maximum size (length) is 3.0 meters. They normally feed on fish and animal carcuses thrown into the rivers. The shark is considered dangeruous and has aggressive feeding behaviour. It has been responsible for a number of attacks on humans within its range.

19.2.2 The Fishery

19.2.2.1 Utilization

The sharks are being utilized by inland communities for subsistence purposes, as a prime source of protein. The sharks are not commercially harvested, since there are demands for the flesh at the local domestic markets.

19.2.3 Stocks Status

There have not been any stock assessment surveys carried out to determine the population dynamics and the status of stocks of the Bull shark.

19.2.4 Management

19.2.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

19.2.4.2 Recommended legislation/policy regarding exploitation

The Department of Fisheries in collaboration with the Environment Unit should consider carrying an in depth stock assessment survey to determine the status of the fresh water shark stocks in the Pankumo River

19.3 FAMILY: MEGALOPIDAE (TARPONS)

19.3.1 The Resource

Order
Elopiformes (tarpons and tenpounders)

Class
Actinopterygii (ray-finned fishes)

Species present
Megalops cyprinoids (Ox-eye Herring)

19.3.1.1 Distribution

Indo-Pacific: Red Sea and Natal, South Africa (Ref. 3969) to the Society Islands, north to southern Korea, south to the Arafura Sea (Ref. 9819) and New South Wales. Restricted to high islands (Palau, Caroline and Mariana islands) in Micronesia. Reported as far inland as the lower Shire in Malawi and the Save-Runde junction in Zimbabwe (Ref. 7248). Widespread in the Lower Zambezi River channels up to Marromeu and in the Micelo River up to Malingapanzi (Ref. 39494). In Vanuatu, this fish is reported only in Malekula and Epi.

Ox-eye Herring inhabits lower reaches of streams, coastal rivers, estuaries and often inhabits the up streams into inland lakes. This species is distributed through out the tropical Indo-West Pacific.

19.3.1.2 Biology and ecology

The fish favours such environments: benthopelagic; amphidromous; freshwater; brackish; marine; depth range - 50 m. Adults are generally found at sea, but young inhabit river mouths, inner bays, and mangrove forests. In freshwater, it occurs in rivers, lagoons, lakes, and swampy backwaters (Ref. 2847). Tolerate salinities from 0 to 100. It is mainly diurnal (Ref. 7017). It is predaceous, feeding mainly on fishes and crustaceans (Ref. 5213).

The fish breeds offshore, possibly throughout the year. Larvae are transparent and resemble larval eels (Ref. 13337). Juveniles commonly enter freshwater (Ref. 48635). Known to breathe air, rising regularly to the surface to do so. The fish can be cultured in ponds, the fry being sourced from the coasts (Ref. 7050). Popular angling fish (Ref. 3969). Edible but not esteemed (Ref. 3969).

Dorsal spines (total): 0; Dorsal soft rays (total): 16-21; Anal spines: 0; Anal soft rays: 23-31. Lower jaw projects beyond snout; a bony gular plate present between the jaw bones. Last fin ray of dorsal long and filamentous; ventrally located pectoral fins; abdominal pelvic fins with 9 or more rays. Branchiostegals more than 23. Scales large. Color blue-green dorsally; silvery on sides. Can tolerate oxygen-poor water by `breathing' air into a lung-like air bladder. Also Ref. 3969. In Vanuatu It normally grows to a fork length of 36.0 cm. The fish has a medium, minimum population doubling time of 1.4 - 4.4 years

19.3.2 The Fishery

19.3.2.1 Utilization

Ox-eye herring is a good angling fish, and the flesh is considered poor to eat. However, it has been recommended for aquaculture. In Vanuatu, for inland communities in Malekula and Epi it provides a source of protein.

19.3.3 Stocks Status

There has not been any stock assessment surveys carried out to determine the population dynamics and the status of stocks of the Ox-eye herring in Vanuatu.

19.3.4 Management

19.3.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

19.3.4.2 Recommended legislation/policy regarding exploitation

Since it does not play a significant role in terms of subsistence and has no commercial value, there is no need at this stage to carry out assessment surveys and thus no need for any management measures to be put into place.

19.4 FAMILY: HEMIRAMPHIDAE

19.4.1 The Resource

Species present
Zenarchopterus sp. (Gar-fishes**)**

19.4.1.1 Distribution

The genus occupies coastal streams inhabiting aquatic vegetation lining the banks of large streams and mangrove swamps. The species is widely distributed from East Africa and across the Pacific. In Vanuatu, the species is only found on Santo Island.

19.4.1.2 Biology and ecology

The biology and ecological studies of the Garfish species has never been carried out in Vanuatu. The fish has a narrow and elongated body shape and silvery in colour. It is easily distinguished by its very short upper jaw. The lower jaw extends to a long beak structure. The body sizes range from 115 mm to 170 mm in length.

19.4.2 The Fishery

19.4.2.1 Utilization

The Garfish species is consumed by other animal kindom species as source of protein.

19.4.3 Stocks Status

There has not been any stock assessment surveys carried out to determine the population dynamics and the status of stocks of the Garfish species in Vanuatu.

19.4.4 Management

19.4.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

19.4.4.2 Recommended legislation/policy regarding exploitation

Since it does not play a significant role in terms of subsistence and has no commercial value, there is no need at this stage to carry out assessment surveys and thus no need for any management measures to be put into place.

19.5 FAMILY: CHANDIDAE (Perchiets)

19.5.1 The Resource

Species present
Ambassis urotaenia. (Bleeker's Glass Perchiets**)**

19.5.1.1 Distribution

The species is widely distributed from India to the Western Pacific. In Vanuatu, the species is only found on Malekula Island. The fish frequently enters estuaries and lower parts of fresh water streams from shallow marine habitats.

19.5.1.2 Biology and ecology

The biology and ecological studies of the Bleeker's Glass Perchiets has never been carried out in Vanuatu. The fish has a semi-transparent body with silvery sheen on head and sides, and a row of single transverse scale on its cheek. It has two dorsal fins and a forked caudal fin. The body is covered with dark scales which formed a network pattern. Maximum body length is 75 mm.

19.5.2 The Fishery

19.5.2.1 Utilization:

Bleeker's Glass Perchiets are consumed by other animal kindom species as source of protein.

19.5.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water fish species in Vanuatu.

19.5.4 Management

19.5.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

19.5.4.2 Recommended legislation/policy regarding exploitation

Since it does not play a significant role in terms of subsistence and has no commercial value, there is no need at this stage to carry out assessment surveys and thus no need for any management measures to be put into place.

19.6 FAMILY: TERAPONTIDAE (Grunters or Tigerperches)

19.6.1 The Resource

Order
Perciformes (perch-likes)

Class
Actinopterygii (ray-finned fishes

Species present
Hephaestus fuliginous (Sooty Grunter**)** and Mesopristes argenteus (Silver Grunter**)**

Silver Grunter

19.6.1.1 Distribution

Western Pacific: Yaeyama Islands (Japan) south to Queensland (Australia) and east to New Caledonia. Large populations have been reported to occur in brackish and freah waters in Papua New Guinea.

The two Grunter species do not share the same habitats. In Vanuatu Sooty grunters are found in the lower reaches of the Jordan River on Santo Island. The fish occupies large rivers and sometimes can be found inhabiting rocky deep pools near waterfalls.

Silver Grunters on the other hand inhabit lower sections of streams and often penetrates into inland deep pools of streams

19.6.1.2 Biology and ecology

The biology and ecological studies of the Sooty Grunter has never been carried out in Vanuatu. Sooty Grunter has a dark grayish and often greenish body colour, with lower regions of the head, breast and belly bearing a whitish colouration. The dorsal and anal fins are short. Maximum body length is 45.0 cm. Juveniles have a large dark blotch on the anal fin and smaller black spot at the base of the last dorsal rays.

Silver Grunters are silvery in colour and have long rigid dorsal and anal spines. Dorsal spines (total): 12; Dorsal soft rays (total): 10-11; Anal spines: 3; Anal soft rays: 8-9. The dorsal caudal and anal fins are yellowish in colour. Its profile is ventrally flattened. Maximum body length is 280 mm. Juvenile Silver Grunters have four distinct black lines on their bodies. It inhabits inshore areas near mangroves. It occurs in lentic and lotic freshwater (Ref. 7300). Juveniles commonly found in the lower sections of creeks and may penetrate several kilometers into fresh water (Ref. 2847). It has an omnivorous diet. Maximum average body length is 28.0 cm.

Silver Grunters favours such habitats as benthopelagic; amphidromous; freshwater; brackish; and marine. They have a medium, minimum population doubling time of 1.4 - 4.4 years (Preliminary K and tmax)

19.6.2 The Fishery

19.6.2.1 Utilization

The two Grunter species provide a significant source of protein for local communities. The fish is locally known as “toktok” fish because of the grumpy sound it makes when fished using hand lines.

19.6.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water fish species in Vanuatu.

19.6.4 Management

19.6.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

19.6.4.2 Recommended legislation/policy regarding exploitation

Since it plays a significant role in the subsistence livelihood of local communities located in close proximity to the Jordan River, it is recommended that an assessment survey is carried out to determine the status of stocks and type of conservation and management measures to be put into place.

Research should also be carried out by the Department of Fisheries on prospects of farming this fresh water fish.

19.7 FAMILY: TERAPONTIDAE

19.7.1 The Resource

Order
Perciformes (perch-likes)

Class
Actinopterygii (ray-finned fishes)

Species present
Terapon jarbua

19.7.1.1 Distribution

Indo-Pacific: Red Sea and East Africa to Samoa, north to southern Japan, south to the Arafura Sea (Ref. 9819), Australia, and Lord Howe Island. Also in India (Ref. 43081). In Vanuatu the fish only recorded on Epi Island.

19.7.1.2 Biology and ecology

The fish prefers such environments as freshwater; brackish; marine and can occupy depths ranging from 20 - 290 m. Found over shallow sandy bottoms, in the vicinity of river mouths. Enter estuaries and rivers (Ref. 1479, 11230, 48635). Adults in loose aggregations (Ref. 48635). Juveniles common in sandy intertidal areas; often in tidal pools. Found in schools (Ref. 9710). Omnivorous diet (Ref. 7300), feeding on fishes, insects, algae, and sand-dwelling invertebrates (Ref. 9710). Spawn in the sea and juveniles migrate into fresh water (Ref. 2847).

Dorsal spines (total): 11-12; Dorsal soft rays (total): 9-11; Anal spines: 3; Anal soft rays: 7-10. Lower opercular spine extending well beyond the opercular flap. Post temporal bone exposed posteriorly and serrate. Body color is fawn above, cream below, nape dark; head, body and fins with and iridescent sheen. Three or four curved dark brown bands run from the nape to the hind part of the body, the lowermost continuing across the middle of the caudal fin. Adults have a large dark blotch on their spinous dorsal fins and stripes on their dorsal fin. Maximum body length is 157 mm.

The fish inhabits lower reaches of streams close to the coast or within estuaries

19.7.2 The Fishery

19.7.2.1 Utilization

Produce sound (Ref. 9137). Marketed fresh, dried or salted (Ref. 12693). However it has a minor commercial value but can be cultured by way of aquaculture in a commercial basis. In Vanuatu the fresh water fish provides a good source of protein for local communities.

19.7.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water fish species in Vanuatu. However, the fish has a low, minimum population doubling time of 4.5 - 14 years (Preliminary K and tmax)

19.7.4 Management

19.7.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

19.7.4.2 Recommended legislation/policy regarding exploitation

Since it plays a significant role in the subsistence livelihood of local communities located in close proximity to the coast and estuaries, it is recommended that an assessment survey is carried out to determine the status of stocks and type of conservation and management measures to be put into place.

Research should also be carried out by the Department of Fisheries on prospects of farming this fresh water fish.

19.8 FAMILY: KUHLIIDAE

19.8.1 The Resource

Order
Perciformes (Perch-likes)

Class
Actinopterygii (ray-finned fishes)

Species present
Khulia rupestris (Jungle Perch)

19.8.1.1 Distribution

Africa to Asia and Oceania: East Africa to Samoa, north to the Ryukyu Islands, south to Queensland, Australia and New Caledonia. In Vanuatu the fish is found in almost all islands that have streams and rivers.

19.8.1.2 Biology and ecology

The fish prefers such habitats as reef-associated; catadromous; freshwater; brackish; and marine. Primarily a freshwater inhabitant but may penetrate adjacent marine habitats (Ref. 41640). Occurs in estuaries and the middle reaches of rivers; usually in relatively fast-flowing, clear streams (Ref. 2847). The fish does not occupy niches above water falls. It is therefore assumed that this fish prefers habitats below waterfalls.

Dorsal spines (total): 10; Dorsal soft rays (total): 10-12; Anal spines: 3; Anal soft rays: 9-11. Preorbital serrae 10-15 (obsolete in large specimens); body depth 2.6-3.0 in SL; mouth large for genus, maxilla reaching to below posterior half of eye; caudal fin emarginated and has a dark blotch at the lobes of the fins, lobes somewhat rounded, caudal concavity 5.3-8.7 in head length. Silvery, the scales dorsally on body with black edges, those on side with a black bar or spot; juveniles with a broad black zone, edged above and below in white, in soft portion of dorsal fin, and each lobe of caudal fin with a large, white-edged black spot; black areas in these fins enlarge with growth until in adults most of these fins black (caudal with upper and lower edges and corners whitish) (Ref. 41640). Maximum body length is 450 mm with maximum published weight of 2,700 g (Ref. 5329)

19.8.2 The Fishery

19.8.2.1 Utilization

Good food fish (Ref. 5329). The fish has a commercial value as well as a good game fish. The fresh water fish provides a significant source of protein for local communities.

19.8.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water fish species in Vanuatu.

19.8.4 Management

19.8.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

19.8.4.2 Recommended legislation/policy regarding exploitation

Since it plays a significant role in the subsistence livelihood of local communities located in close proximity to streams and rivers, it is recommended that an assessment survey is carried out to determine the status of stocks and type of conservation and management measures to be put into place.

Research should also be carried out by the Department of Fisheries on prospects of farming this fresh water fish.

19.9 KUHLIDAE

19.9.1 The Resource

Order
Perciformes (perch-likes)

Class
Actinopterygii (ray-finned fishes)

Species present
Khulia munda

19.9.1.1 Distribution

Oceania: Fiji, Vanuatu, New Caledonia and Queensland, and Australia. In Vanuatu the fish is found in almost all islands that have streams and rivers.

19.9.1.2 Biology and ecology

The fish inhabits such environments as benthopelagic; freshwater; and brackish. In Vanuatu the fish inhabit coastal reaches of streams and estuaries

Dorsal spines (total): 10; Dorsal soft rays (total): 10-11; Anal spines: 3; Anal soft rays: 11. Preorbital serrae 14-21; body depth 2.55-2.85 in SL; orbit diameter 2.55-2.8 in head length; maxilla usually reaching to below anterior margin of pupil; caudal concavity 2.5-3.0 in head length. Silvery, front of lips and upper half of snout blackish; caudal fin yellow with a very broad black posterior margin, the upper and lower margins narrowly black, but broadening towards base, often connecting across base of fin (Ref. 41640). Average body length is 110 mm.

19.9.2 The Fishery

19.9.2.1 Utilization

The fresh water fish provides a significant source of protein for local communities.

19.9.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water fish species in Vanuatu.

19.9.4 Management

19.9.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

19.9.4.2 Recommended legislation/policy regarding exploitation

Since it plays a significant role in the subsistence livelihood of local communities located in close proximity to the coastal reaches of streams and estuaries, it is recommended that an assessment survey is carried out to determine the status of stocks and type of conservation and management measures to be put into place.

Research should also be carried out by the Department of Fisheries on prospects of farming this fresh water fish.

19.10 FAMILY: CARANGIDAE (Jacks and Pompanos)

19.10.1 The Resource

Order
Percifomes (perch-likes)

Class
Actinopterygii (ray-finned fishes)

Species present
Caranx sexfasciatus (Bigeye trevally)

19.10.1.1 Distribution

Indo-Pacific: Red Sea and East Africa to Hawaii, north to southern Japan and the Ogasawara Islands, south to Australia and New Caledonia. Eastern Pacific: southwestern coast of Baja California Sur, Mexico and the Gulf of California to Ecuador and the Galapagos Islands (Ref. 9283). In Vanuatu the fish is only found on Santo and Malekula Islands.

19.10.1.2 Biology and ecology

The fish prefers to inhabit such environments as reef-associated; amphidromous; freshwater; brackish; marine; and can occupy depths range up to 96.0 m. It inhabits coastal and oceanic waters associated with reefs (Ref. 9283). Occasionally enters rivers. Juveniles may be encountered in estuaries (Ref. 9283), occasionally entering rivers and penetrating well inland (Ref. 2847). Forms slow-moving schools in the passes or outside the reef during the day, dispersing at night feed (Ref. 4795). Feeds mainly on fishes and crustaceans (Ref. 9283).

Dorsal spines (total): 9; Dorsal soft rays (total): 19-22; Anal spines: 3; Anal soft rays: 14-17. Body color iridescent blue-green dorsally, silvery white below; soft dorsal lobe and anal fin with white-tipped lobes; caudal yellowish to black. Pectoral fins falcate; anal fin with 2 detached spines. Upper edge of opercle with a small blackish spot. 27-36 strong, dark scutes. Breast fully scaled.

Average body length is 250 mm, however are able to growth up to 750 mm in body length with maximum published weight of 18.0 kg (Ref. 9987).

19.10.2 The Fishery

19.10.2.1 Utilization

Marketed fresh, dried or salted (Ref. 9283) and frozen (Ref. 9987). Consumed broiled and baked (Ref. 9987). It has a commercial value and has been reported to be a good gamefish. In Vanuatu this fish provides a good source of protein for local communities.

Stocks Status
No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water fish species in Vanuatu. However, the fish has a low, minimum population doubling time 4.5 - 14 years (Preliminary K and tmax).

19.10.3 Management

19.10.3.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

19.10.3.2 Recommended legislation/policy regarding exploitation

Since it plays a significant role in the subsistence livelihood of local communities located in close proximity to the estuaries and large inland river systems, it is recommended that an assessment survey is carried out to determine the status of stocks and type of conservation and management measures to be put into place.

Research should also be carried out by the Department of Fisheries on prospects of farming this fresh water fish.

19.11 LUTJANIDAE (Snappers)

19.11.1 The Resource

Order
Percifomes (perch-likes)

Class
Actinopterygii (ray-finned fishes)

Species present
Lutjanus argentimaculatus (Mangrove red snapper)

19.11.1.1 Distribution

This fish is subtropical and is widely distributed throughout Indo-West Pacific and East Africa to Samoa and the Line Islands, north to the Ryukyu Islands, south to Australia and has dispersed into the eastern Mediterranean (off Lebanon) via the Suez Canal but not well established there. In Vanuatu the fish is found on Santo, Efate, Erromango and Malekula Islands.

19.11.1.2 Biology and ecology

The fish is reef-associated; oceanodromous; freshwater; brackish; marine; depth range 10-120 m. Juveniles and subadults favour estuaries or lower section of freashwater streams.

Dorsal spines (total): 10; Dorsal soft rays (total): 13-14; Anal spines: 3; Anal soft rays: 7-8. Preopercular notch and knob poorly developed. Scale rows on back more or less parallel to lateral line, or parallel below spinous part of dorsal fin and sometimes rising obliquely posteriorly, or rarely with entirely oblique rows. Generally greenish brown on back, grading to reddish on sides and ventral parts. Trawl specimens from deep water frequently are reddish with dark scale centers and white scale margins, giving a reticulated appearance. Juveniles with a series of about eight whitish bars crossing sides, and 1 or 2 blue lines across cheek. *L. argentimaculatus* distinguished from the *L. bohar* by its longer snout and truncate tail and more bronze to greenish coloration (Ref. 37816).

A euryhaline species (Ref. 12743). Juveniles and young adults occur in mangrove estuaries and in the lower reaches of freshwater streams (Ref. 30573, 48635). Adults are often found in groups around coral reefs (Ref. 9710). Eventually migrate offshore to deeper reef areas, sometimes penetrating to depths in excess of 100 m. Mainly nocturnal, this species feeds mostly on fishes and crustaceans. Excellent food fish (Ref. 5484). An important market species throughout the Indo-Pacific region, but never found in large quantities. A good aquaculture species because it doesn't get rancid easily when frozen (Ref. 47992). It commands a good export market price with no limit on body size (Ref. 47992). No reported damaging diseases (Ref. 47992). Found in Hong Kong live fish markets (Ref. 27253). Average body length is 340 mm with maximum published weight of 8,700 g and maximum reported age of 18 years.

19.11.2 The Fishery

19.11.2.1 Utilization

This fish has a commercial value and can be easily culture by way of aquaculture. It is also a preferred fish for gamefishing purposes. In Vanuatu the fresh water fish provides a significant source of protein for local communities.

19.11.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this sub-fresh water fish species in Vanuatu.

19.11.4 Management

19.11.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

19.11.4.2 Recommended legislation/policy regarding exploitation

Since it plays a significant role in the subsistence livelihood of local communities located in close proximity to the estuaries or lower section of freashwater streams, it is recommended that an assessment survey is carried out to determine the status of stocks and type of conservation and management measures to be put into place.

Research should also be carried out by the Department of Fisheries on prospects of farming this fresh water fish.

19.12 LUTJANIDAE

19.12.1 The Resource

Species present

Lutjanus fuscescens (Spotted Bass)

19.12.1.1 Distribution

The species occurs in China, Philippines, Papua New Guinea, Solomon Islands and Australia. In Vanuatu the fish is found on Santo Island.

19.12.1.2 Biology and ecology

The biology and ecological studies of *Lutjanus fuscescens* have never been carried out in Vanuatu.

The fish has a single dorsal fin with greenish brown coloration on its back and white ventral parts. The upper back has a large dark in colour. Average body length is 400 mm, however overall fork length may be bigger.

The fish is partly marine species with adults found within coastal reef or deeper offshore areas. Juveniles and subadults favour estuaries or lower section of fresh water streams.

19.12.2 The Fishery

19.12.2.1 Utilization

The fresh water fish provides a significant source of protein for local communities.

19.12.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this sub-fresh water fish species in Vanuatu.

19.12.4 Management

19.12.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

19.12.4.2 Recommended legislation/policy regarding exploitation

Since it plays a significant role in the subsistence livelihood of local communities located in close proximity to the estuaries or lower section of freashwater streams, it is recommended that an assessment survey is carried out to determine the status of stocks and type of conservation and management measures to be put into place.

Research should also be carried out by the Department of Fisheries on prospects of farming this fresh water fish.

19.13 LUTJANIDAE

19.13.1 The Resource

Species present
Lutjanus russelii

19.13.1.1 Distribution

The species occurs throughout the Indo-Pacific including New Caledonia. In Vanuatu the fish is only found on Gaua.

19.13.1.2 Biology and ecology

The biology and ecological studies of *Lutjanus russelii* have never been carried out in Vanuatu.

The fish has a single dorsal fin with four distinct longitudinal stripes across its golden yellow body. Average body length is 110 mm. The fish inhabits lower reaches of streams near coastal areas.

19.13.2 The Fishery

19.13.2.1 Utilization

The fresh water fish are consumed by other animal kindom species as source of protein. It does not provide a significant source of protein for local communities.

19.13.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this sub-fresh water fish species in Vanuatu.

19.13.4 Management

19.13.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

19.13.4.1 Recommended legislation/policy regarding exploitation

Since it does not play a significant role in terms of subsistence and has no commercial value, there is no need at this stage to carry out assessment surveys and thus no need for any management measures to be put into place.

19.14 FAMILY: GERRIIDAE (Silver Biddies)

19.14.1 The Resource

Order
Percifomes (perch-likes)

Class
Actinopterygii (ray-finned fishes)

Species present
Gerres filamentosus (Thread Silver-Biddy)

19.14.1.1 Distribution

Indo-Pacific: East Africa and Madagascar to Japan and Australia. Reported from New Caledonia. Enters rivers and lakes in Madagascar and the east coast of Africa. In Vanuatu it is found only on Efate, Malekula and Maewo.

The species occurs throughout the East Africa, the tropical Indo-Pacific Australia and Eastern Pacific Island groups. In Vanuatu the fish is found.

19.14.1.2 Biology and ecology

Dorsal spines (total): 9; Dorsal soft rays (total): 10-11; Anal spines: 2-3; Anal soft rays: 7-8. Color generally silvery. Second dorsal-fin spine very long. Vertical series of spots along the side. Average body length is 220 mm.

Marine species that may enter lakes and lower fresh water reaches of rivers. Juveniles are found in brackish mangrove estuaries and sometimes enter fresh water. Inhabits shallow water over sandy substrates along the coasts and in estuaries . Feeds on small crustaceans, polychaetes and forams on sand or muddy-sand bottoms, worms and insect larvae.

The fish prefers such environments as demersal; amphidromous; freshwater; brackish; marine; and can occupy depths ranging from 10 - 50 m. Normally the fish lives in mangrove areas, estuaries and shallow marine areas.

19.14.2 The Fishery

19.14.2.1 Utilization

This fish has a commercial value. It is normally salted or made into fish sauce. In Vanuatu this fresh water fish provides a significant source of protein for local communities.

19.14.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this sub-fresh water fish species in Vanuatu. However, this fish has a High, minimum population doubling time less than 15 months (Preliminary K and tmax)

19.14.4 Management

19.14.4.1 Current legislation/policy regarding exploitation:

No current legislation to manage the exploitation of the resource

19.14.4.1 Recommended legislation/policy regarding exploitation

Since it plays a significant role in the subsistence livelihood of local communities located in close proximity to the mangrove areas, estuaries and shallow marine areas, it is recommended that an assessment survey is carried out to determine the status of stocks and type of conservation and management measures to be put into place.

Research should also be carried out by the Department of Fisheries on prospects of farming this fresh water fish.

19.15 MONODACTYLIDAE

19.15.1 The Resource

Species present
Monodactylus argenteus (Silver-moon Fish)

19.15.1.1 Distribution

Indo-West Pacific: Red Sea and East Africa to Samoa, north to the Yaeyamas, south to New Caledonia and Australia.

Known from the fresh water tidal zone of the Mekong delta. The species is widespread from India, and Papua New Guinea. In Vanuatu the fish is found only on Santo.

19.15.1.2 Biology and ecology

Commonly found in mangrove estuaries, often entering creeks. Sometimes found in silty coastal reefs. Small juveniles are solitary or can live in small aggregations. The fish can live in fresh water. It feeds on plankton and detritus. It is highly territorial and be caught with throw nets. The fish has a diamond body shape. It is also called a Butterfly fish. Juveniles tend to have pelvic fins, which are absent in adults. Average body length is 250 mm.

Dorsal spines (total): 7-8; Dorsal soft rays (total): 27-31; Anal spines: 3; Anal soft rays: 27-32. Adults are bright silver with yellow and dusky dorsal fin tip. Small juveniles are more colorful with yellow over most of the dorsal fin and two vertical black bands over the head.

19.15.2 The Fishery

19.15.2.1 Utilization

The fish has a minor commercial value. However it is highly sort for the aquarium trade industry. In Vanuatu the fresh water fish provides a significant source of protein for local communities.

19.15.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water fish species in Vanuatu.

19.15.4 Management

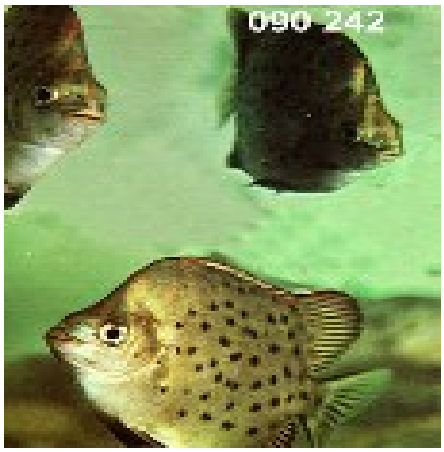
19.15.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

19.15.4.2 Recommended legislation/policy regarding exploitation

Since it plays a significant role in the subsistence livelihood of local communities located in close proximity to the large streams close to the coast, it is recommended that an assessment survey is carried out to determine the status of stocks and type of conservation and management measures that would be put into place to ensure long term sustainable utilization of this resource.

19.16 SCATOPHAGIDAE



19.16.1 The Resource

Species present
Scatophagus argus (Spotted Scat)

19.16.1.1 Distribution

Indo-Pacific: Kuwait to Vanuatu and New Caledonia, north to southern Japan; Palau to Pohnpei in Micronesia. Reported from Samoa and the Society Islands. Throughout India, Sri Lanka, Malaysia, Singapore, and northern part Australia. In Vanuatu the fish is found only on Malekula.

19.16.1.2 Biology and ecology

Inhabit harbors, natural embayments, brackish estuaries and the lower reaches of fresh water streams, frequently occurring among mangroves. Feed on worms, crustaceans, insects and plant matter. The dorsal, anal and pelvic spines are believed by Philippine fishers to be venomous and capable of inflicting wounds. Used in Chinese medicine. In Hong Kong it can be found in live fish markets. Marketed as fresh fish.

The fish is also called a Butterfly fish and is brown with reddish brown round spots on its body. The head profile ascends steeply with a deep concavity above its eyes. Dorsal spines (total): 10-11; Dorsal soft rays (total): 16-18; Anal spines: 4; Anal soft rays: 13-15. Average maximum body length is 380 mm.

The fish is very resilient and has a high, minimum population doubling time of less than 15 months.

19.16.2 The Fishery

19.16.2.1 Utilization

In some countries the fish is one of the preferred species for aquaculture, because of its commercial value. In Vanuatu the fresh water fish provides a significant source of protein for local communities.

19.16.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water fish species in Vanuatu.

19.16.4 Management

19.16.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

19.16.4.2 Recommended legislation/policy regarding exploitation

Since it plays a significant role in the subsistence livelihood of local communities located in close proximity to the large streams close to the coast, it is recommended that an assessment survey is carried out to determine the status of stocks and type of conservation and management measures to be put in place to sustainably conserve this resource.

19.17 MUGILIDAE (Mullets)

19.17.1 The Resource

Species present
Four species of fresh water mullets are found in Vanuatu:

Cestraceus guamensis (White Mullet)
Cestraceus plicatilis (Black Mullet)
Mugil cephalus
Crenimugil crenilabis

19.17.1.1 Distribution

The species are commonly widespread throughout the tropical Indo-West and Central Pacific. In Vanuatu, *Cestraceus guamensis* is found only on three islands, Santo, Maewo and Pentecost; *Cestraceus plicatilis* (Black Mullet) is found almost on all islands with large streams; *Mugil cephalus* is recorded only on Erromango and Aneityum islands; and *Crenimugil crenilabis* on Pentecost island only.

19.17.1.2 Biology and ecology

The biology and ecological studies of the fresh water Mullet fish species have never been carried out in Vanuatu.

Mullets are generally characterized by their silvery elongated body shape with a small mouth having fine or no teeth. They possess two well separated dorsal fins with the first dorsal fin having 4 spines. The eyes are generally partly surrounded by adipose tissue. Mullets are common throughout the large streams in Vanuatu. In 1992, Ryan reported two other species of Mullet, Lisa subviridis and Lisa crenilabis in Vanuatu, which are now thought to be extinct in Vanuatu.

Cestraceus guamensis:
This species can be identified by it silvery white elongated body, and is often refered to as White Mullet. It has a adipose eyelid and an elongated jaw which extends below the eye. The Mullet has large scales and indistinct lateral line. This species inhabits the lower reaches of streams near coast. Adults may move inland via large steams. Average fork length is 180 mm.

***Cestraceus plicatilis* (Black Mullet):**
This species is characterized by its long jaw, which extends to below the eye. It's eyes are partly surrounded by adipose eyelid. The fish possesses indistinct lateral line. The posterior end of the lower jaw has 2 to 4 rounded fleshy lobes. The body upper part is greyishly shaded, silvery white on the side and belly. The Mullet inhabits lower reaches of streams near coast. Adults may be found well inland up to altitudes of 300 m in large and fast flowing streams.

***Mugil cephalus**:*
This species is characterised by having an olive green colouration on its back, silvery sides and a silvery-white belly. It has a dark blotch at the base of its pectoral fin and has longtitudinal faint brown stripes on its body and a white face on its ventral side. This Mullet species inhabits shallow coastal seas and often enters estuaries or lower parts of streams. Average fork length is 600 mm.

Crenimugil crenilabis
This species is characterized by having clearly marginate caudal fin and has a smaller mouth. It does not possess adipose eyelids, or if present, are poorly developed. The body colour is greenish to grey on the back, with silvery colour on the sides and belly. Average fork length is 180 mm but can grow bigger.

19.17.2 The Fishery

19.17.2.1 Utilization

All four species of the fresh water mullet provide a significant source of protein for local communities. Surplus is sold locally to generate rural income.

19.17.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water fish species in Vanuatu.

19.17.4 Management

19.17.4.1 Current legislation/policy regarding exploitation:

No current legislation to manage the exploitation of the resource

19.17.4.2 Recommended legislation/policy regarding exploitation:

Since it plays a significant role in the subsistence livelihood of local communities located in close proximity to the large streams close to the coast, it is recommended that an assessment survey is carried out to determine the status of stocks and type of conservation and management measures to be put into place.

Research studies should also be carried out by the Department of Fisheries on all four Mullet species, to determine the prospects for commercial farming.

19.18 BLENNIDAE

19.18.1 The Resource

Species present
Meiacanthus anema

19.18.1.1 Distribution

Asia and Oceania: Indonesia, Philippines, New Guinea, Solomon Islands, and Vanuatu. Reported from New Caledonia. In Vanuatu the fish is found only on Efate Island.

19.18.1.2 Biology and ecology

Occurs in estuaries and freshwater habitats, particularly the lower reaches of shallow fresh water pools of rivers and streams, frequently where mangroves are abundant. Has toxic buccal glands associated with the grooved canines. This is avoided by predators, which even reject it unharmed if they try to ingest it.

Blennies are small colourful fishes with 3 distinct longtitudinal dark or black stripes on their bodies. The fish has an elongated body shape with no scales and a long-based dorsal fin. Average maximum body length is 7.2 cm.

The fish is very resilient and has an ability for medium, minimum population doubling time 1.4 - 4.4 years

19.18.2 The Fishery

19.18.2.1 Utilization

The fish has an aquarium trade value. However in Vanuatu this does not play a significant role in the livelihood of the local communities. The fish is mainly preyed by carnivorous birds and other fishes living in the river systems.

19.18.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water fish species in Vanuatu.

19.18.3.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

19.18.3.2 Recommended legislation/policy regarding exploitation

Since it does not play a significant role in terms of subsistence and has no commercial value, there is no need at this stage to carry out assessment surveys and thus no need for any management measures to be put into place.

19.19 ELEOTRIDAE (Gudgeons)

19.19.1 The Resource

Species present:
There are 8 species found in Vanuatu:
Belobranchus belobranchus (Throatspine Gudgeon), *Eleotris fusca* (Brown Gudgeon), *Hypseleotris guentheri* (Rainbow Prigi), *Ophieleotris aporos var. aporos* (Snakehead Gudgeon), *Ophieleotris aporos new var., Ophieleotris aporos var. geuntheri, Ophieleotris porocephala* (Spangled Gudgeon), and *Oxyeleotris sp.* (Sleeper Goby)


Belobranchus belobranchus

19.19.1.1 Distribution

Belobranchus belobranchus (Throatspine Gudgeon):
The species is found in Indonesia, the Philippines, and Papua New Guinea. In Vanuatu the fish is found only on Maewo, Pentecost and Efate Islands.

Eleotris fusca (Brown Gudgeon)
The species is found in Papua New Guinea and widely distributed through out the Pacific Island countries. In Vanuatu, the fish is found on almost all islands having river systems and streams.

Hypseleotris guentheri (Rainbow Prigi)
The species is found in Indonesia, Papua New Guinea, New Caledonia, Fiji, and Samoa. In Vanuatu the species is found only on Pentecost, Malekula, Epi, Efate and Erromango Islands.

Ophieleotris aporos var. aporos (Snakehead Gudgeon)
The fish is widespread within the Indo-West Pacific. In Vanuatu, it is only found on Santo, Maewo, Pentecost, Malekula Islands.

Ophieleotris aporos new var.

The species is reported to be found only in New Caledonia. In Vanuatu the fish is found in Pentecost, Santo and Efate.

Ophieleotris aporos var. geuntheri
The fish is found in New Caledonia. In Vanuatu it is found on Santo and Malekula.

Ophieleotris porocephala (Spangled Gudgeon)
The species is widespread throughout high volcanic islands of Oceania. In Vanuatu it is found on Santo, Malekula, Vanua Lava and Efate.

Oxyeleotris sp. (Sleeper Goby)
The fish is found only on Vanua Lava, Maewo and Pentecost Islands.

19.19.1.2 Biology and ecology

The fish is generally characterized by having an elongated body and fairly flattened head. It has 2 separate pelvic fins. They are normally stream bottom dwellers.

Belobranchus belobranchus (Throatspine Gudgeon):
This fresh water fish species are dark brown in colouration or with 5 broad light bars across the body. The body also has numerous dark horizontal lines on sides with light spots forming lines radiating from eye across the cheeks. Fins may have spots. The fish occupies lower reaches of streams with rocky or gravel bottoms. Average body length is 103 mm.

Eleotris fusca (Brown Gudgeon)
The fish is characterized by having a downward projecting spine at the lower corner of preopercle margin and numerous dark horizontal lines on its body. The fish is common throughout all parts of the stream below waterfalls. Average body length is 150 mm.

Hypseleotris guentheri (Rainbow Prigi)
This species has dorsal fins with white spot in males and fainted spots in female dorsal fins. It inhabits shallow pools within lower and mid reaches of clear fast flowing streams. Average body length is 50 mm.

Ophieleotris aporos var. aporos (Snakehead Gudgeon)
The fish has 2 to 4 brown stripes radiating from the lower part of the eye across the cheek. The fin margins are yellow in colour. It has a number of transverse scales. It occupies lower reaches or estuaries of large rivers, swamps and lakes. Average body length is 201 mm.

Ophieleotris aporos new var.
The fish has a broad compressed head and a number of transverse scales. The colour of the body is yellow with dark red blotch arranges longitudinally on the body. It has dark reddish fins with yellow margins and 3 dark stripes radiating from the lower part of the eyes across the

cheeks. At the base of the pectoral fin there is a dark blotch. The fish inhabits the lower reaches within pools of clear fast flowing streams. Average body length is 230 mm.

Ophieleotris aporos var. guentheri
The fish has a spotted body with longtitudinal spotted lines along the body and white spotted fins. Females do not have spots on the body. It inhabits lower and mid reaches of large streams. Average body length is 129 mm

Ophieleotris porocephala (Spangled Gudgeon)
The fish has a dark brown with scattered white spots on the sides of its body. The scales are arranged to form longtitudinal body lines. The fins have yellow margins. The fish inhabits the lower stream parts, estuaries and freshwater creek pools. Average body length is 180 mm.

Another species *Ophieleotris macrolepidota* was reported in Vanuatu in 1992 by Ryan. However, it appears that this species may now be extinct.

Oxyeleotris sp. (Sleeper Goby)
The fish has a head, which is fairly compressed, with complete separate pelvic fins. It has a tanish brown colouration with narrow dark lines. It has tan, brown blotches usually on sides of the head and lips. The pectoral fins have white spots. The fish inhabits muddy bottom of streams near coasts. The fish is considered an important source of food for local communities. Average body length is 350 mm.

19.19.2 The Fishery

19.19.2.1 Utilization

Apart from the Sleeper Goby, all the Gudgeon species do not seem to play a significant role in the livelihood of the local communities.

19.19.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water fish species in Vanuatu.

19.19.4 Management

19.19.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

19.19.4.2 Recommended legislation/policy regarding exploitation

It may be relevant for the Department of Fisheries in collaboration with the Environment Unit to carry out an extensive assessment on the status of stocks of the Gudgeon fishes. Given the fact that three of the species may have disappeared for good in Vanuatu, it may be essential to consider implementing some strict management measures.

19.20 FAMILY: GOBIDDAE (Gobies)

19.20.1 The Resource

Species present

The following 11 species are found in Vanuatu: *Awaous guamensis; Awaous ocellaris; Glossogobius celebius* (Celebes Boby); *Mugilogobius fusculus* (Obscure Boby); *Periophthalmus argentilineatus* (Silverstripe Mudskipper); *Periophthalmus weberi* (Weber's mudskipper); *Redigobius bikolanus* (Speckled Goby); *Sicyopterus laceocephalus* (Micrurus); *Sicyopterus cyanocephalus; Sicyopterus sp.;* and *Vevineala pyrrhotigris.*

Awaous guamensis

19.20.1.1 Distribution

Awaous guamensis:
The species inhabits the lower parts of streams among algal mats at the bottom of the streams. The species occurs only within the Pacific plate island groups such as, the Solomon Islands, New Caledonia; the Marianas, Hawaii Islands. In Vanuatu the fish is found only on Aneityum Island.

Awaous ocellaris
The species inhabits the middle reaches of the streams with sandy bottom substrates. It is found in South Papua New Guinea and Northern Australia. In Vanuatu, the fish is found on Maewo and Malekula Islands.

Glossogobius celebius (Celebes Boby)
This goby species inhabits the lower reaches of wide streams. The species commonly found in the Western Tropical Pacific. In Vanuatu the species is found only on Pentecost, Malekula, Epi, Efate and Maewo Islands.

Mugilogobius fusculus (Obscure Boby)
The fish occupies lower reaches of streams particularly within estuaries. It is found throughout the Indo-Pacific. In Vanuatu, it is only found on Maewo Island.

Periophthalmus argentilineatus (Silverstripe Mudskipper)
The species is reported to occupy the lower reaches of streams particularly within extensive brackish mangrove areas. It occurs throughout the West Indo Pacific including Vanuatu where it is found only on Malekula Island.

Periophthalmus weberi (Weber's mudskipper)
The fish inhabits tidal freshwater within mangrove areas. It is found in South Papua New Guinea, Northern Australia and in Vanuatu where it is recorded only Malekula Island.

Redigobius bikolanus (Speckled Goby)
The species inhabits lower parts of streams. It is found in Japan, Philippines, Indonesia, Papua New Guinea, Northern Australia. In Vanuatu it is found on Efate Island.

Sicyopterus laceocephalus (Micrurus)
The fish posses well developed suckers, which enables it to climb rocks and move further into inland waters. It is therefore found throughout all parts of the streams from lower to the upper reaches. The fish is widespread throughout the Western and Central Pacific Island groups. In Vanuatu this fish is a common resident in all fast flowing streams.

Sicyopterus cyanocephalus
This fish inhabits fast flowing streams where bottom substrates comprise mainy of stones and boulders. It is found in the Philippines, Papua New Guinea and Indonesia. In Vanuatu it is found only on Pentecost Island.

Sicyopterus sp
This goby species is found within lower parts of streams that are fairly undisturbed. It is found on Efate, Pentecost and Maewo Islands.

Vevineala pyrrhotigris
This is an endemic genus with only one species found on Ambae and Maewo Islands.

19.20.1.2 Biology and ecology

This family of the Goby species is generally a stream bottom dweller having flattened head. The pelvic fins are fused to form a sucker that enables the fish to attach themselves on to rocks while feeding.

Awaous guamensis:
The species has a duck-beak like mouth shape. It lacks cheek scales. It has 2 seperate dorsal fins and a rounded caudal fin. It has broad jaws which extends back to below the eyes. The body is brownish in colour with longtitudinal rows of dark spots. As a defensive behaviour, the fish often take cover by diving into the algal substrate when threatened. Average body length is 106 mm.

Awaous ocellaris
The species lacks cheek scales. It is brown in colour with mid-lateral rows of 6 – 7 irregular dark brown blotches and numerous small brown blotches on the entire body. It has a triangular dark brown mark on the upper pectoral fin. Average maximum length is 100 mm.

Glossogobius celebius (Celebes Boby)
The fish has a flattened head and more rounded snout compared to the genus Awaous. It has broad cheeks that lack scales. The colour of the body is brown with 5 dark broen blotches on the middle on the middle of sides. It has an orange and dark blotch at the tail end base of the dorsal fin. Average maximum body length is 120 mm.

Mugilogobius fusculus (Obscure Boby)
The fish has broad cheeks without scales. The scale is only present on the opercule. It has rounded caudal fin and the first dorsal fin spine forms an elongated filament. Average maximum body length is 31 mm.

Periophthalmus argentilineatus (Silverstripe Mudskipper)
The species lacks cheek scales. It has protruded eyes over its head. It has broad black stripe with narrow white margin on the first and second dorsal fins. Outer edge of the second dorsal fin is broadly reddish in colour. The pelvic fins are partly fused. Average maximum body length is 27 mm.

Periophthalmus weberi (Weber's mudskipper)
The fish has a fairly flattened head. Its cheek lacks scales. It has protruded eyes and its pelvic fins are partly fused.

Redigobius bikolanus (Speckled Goby)
Its head is fairly flat and lack cheek scales. It has 3 faint brown bars on the head. It has a brown body with dark spots and blotches. It has 26-28 mid-lateral scales and 7 transverse scales. Average maximum body length is 35 mm.

Sicyopterus laceocephalus (Micrurus)
The fish lack cheek scales. It has tear marks that extend vertically onto mouth ends. It has orange caudal fins with black margin, which is prominent in adults. It has 17 transverse scales and an average maximum body length of 70 mm.

Sicyopterus cyanocephalus
This fish lacks scales and has tear marks that extend vertically onto mouth ends. It has two separate dorsal fins. The second dorsal fin may have a dark spot. Its body possesses 7 – 8 black bars spread across the body. It also has longtitudinal line of blotches along the body. The scales in the interior part of the body are smaller than those within the mid body. It has 17 transverse scales. Average maximum body length is 110 mm.

Sicyopterus sp
Its cheek lacks scales. It has tear marks extending vertically onto its mouth end. It has orange caudal fins and two separate dorsal fins. It has a light brown body colour with a dark orange line extending along the side from the body center to the base of the caudal fin. The size of the body scales are smaller compared to those of *S. lacocephalus*. Average body length is known to be 50 mm.

Vevineala pyrrhotigris
It is generally a narrow elongated small bodied fish. It has strong circular fused pelvic fins with a strong freanum with a reddish blood appearance when alive which fades into a brown colour when dead and preserved. The scales have black margins which form a rigid black transverse marks on the body from anal fin to base of the caudal fin. Average known body length is 21 mm.

19.20.2 The Fishery

19.20.2.1 Utilization

All the Goby species do not play a significant role in the livelihood of the local communities.

19.20.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water fish species in Vanuatu.

19.20.4 Management

19.20.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

19.20.4.2 Recommended legislation/policy regarding exploitation

It may be relevant for the Environment Unit and the Fisheries Department to carry out assessment studies on habitat damage which may have resulted in great depletion of a number of the Goby species in Vanuatu.

19.21 FAMILY: GOBIDDAE, Genus Sicyopus

19.21.1 The Resource

Species present:
Sicyopus zosterophorum

19.21.1.1 Distribution

Sicyopus zosterophorum occurs within the upper reaches of streams within pools of creeks. The genus is found mainly in the West Indo Pacific. In Vanuatu the fish is found only on Ambae and Pentecost.

19.21.1.2 Biology and ecology

The fish has an elongated and fairly compressed narrow body. Average body size is 25 mm in length. The fish has a scaleless head and has two separate dorsal fins. The eyes are positioned above the end of the mouth. There are dark stripes across the body, which are more distinct in males than in females

19.21.2 The Fishery

19.21.2.1 Utilization

This fish does not play a significant role in the livelihood of the local communities

19.21.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water fish species in Vanuatu

19.21.4 Management

19.21.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

19.21.4.2 Recommended legislation/policy regarding exploitation

It may be relevant for the Environment Unit and the Fisheries Department to carry out assessment studies on habitat damage, which may have resulted in population reduction of this genus.

19.22 FAMILY: GOBIDDAE (Miniature Gobies)

19.22.1 The Resource

Genus present
Stenogobius

19.22.1.1 Distribution

This genus occurs within all parts of the streams. It is widely distributed across the Pacific. In Vanuatu it is recorded on Efate, Erromango and Maewo.

19.22.1.2 Biology and ecology

There are two species of this genus, which are new species and have not been named yet. *Stenogobius species (1)* has a conspicuous black tear mark stripe below the eye extending behind the end of its mouth. It has 10-12 black bars across its body. Average body length is 71 mm.

Stenogobius species (2) lacks conspicuous dark bars across its body and has an orange caudal fin with a dark margin. Average body length is 87 mm.

19.22.2 The Fishery

19.22.2.1 Utilization

This fish does not play a significant role in the livelihood of the local communities.

19.22.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water fish species in Vanuatu.

19.22.4 Management

19.22.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

19.22.4.2 Recommended legislation/policy regarding exploitation

It may be relevant for the Environment Unit and the Fisheries Department to carry out assessment studies on habitat damage, which may have resulted in population reduction of this genus. The third species, Stenogobius genivittatus was reported in Vanuatu by Ryan in 1992. This species may have now become extinct in Vanuatu.

19.23 FAMILY: GOBIDDAE – GENUS Stiphodon

19.23.1 The Resource

Species present
Stiphodon rutilaureus

19.23.1.1 Distribution

This species occupies bottom of streams and thus are common within shallow clear pools in the lower parts of the streams near the coasts. The species occurs throughout Malaysia, Indonesia, Papua New Guinea and many Pacific Island groups. In Vanuatu it is recorded on Efate, Erromango, Maewo, Santo and Vanua Lava.

19.23.1.2 Biology and ecology

This species has a strong circular fused pelvic fins with a freanum edge which when alive is red in colouration and brown in colour when dead. The fish has a flattened head and 2 separate dorsal fins. The males have colourful fins with a filamentous ray at the 1st dorsal fin. Female have fairly brown body with longtitudinal line of dark blotches along the body side. Males have been observed to swim in a group of 2 or 3 with one female within streams.

The genus has several species which have been reported in Vanuatu. *Stiphodon elegans* and *Stiphodon astilbos* were recorded in Santo by Ryan (1992). These species are thought to be extinct now in Vanuatu.

19.22.2 The Fishery

19.22.2.1 Utilization

This fish does not play a significant role in the livelihood of the local communities.

19.22.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water fish species in Vanuatu.

19.22.4 Management

19.22.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

19.22.4.2 Recommended legislation/policy regarding exploitation

It may be relevant for the Environment Unit and the Fisheries Department to carry out assessment studies on habitat damage, which may have resulted in population reduction of this genus.

20. INTRODUCED FRESH WATER FISHES

A number of exotic fresh water fishes have been introduced in Vanuatu either to assist in the control of mosquito larvae propagation by the Health authorities or to improve nutritient as food fish. While the introductions of exotic fish species were done in the past with good intentions, for example to increase food production and as biological controls, the environmental impact if not properly may be negative. The introduced species are more resilient and thus compete rigorously for limited space and food supply, often feeding on native fishes and prawns species (including their larvae).

20.1 FAMILY: POECILIIDAE (Liver Bearers)

20.1.1 The Resource

Species present
Peocillia reticulate (Guppies)

20.1.1.1 Distribution

This species is a native to northeastern South America and the West Indies. It was brought into Vanuatu to help control malaria. Large populations are observed in Lake Wailenitaka on Ambae Island.

20.1.1.2 Biology and ecology

This species is considered a pest to the native fresh water fauna due to its rapid breeding habits and ability to dominate and crowding out local native fish species.

Female can reach a maximum size of 50 mm and male 25 mm. The fish has 7 – 8 dorsal fin rays. Females have prominent rounded bellies while the males are more slender. They posess 26 – 28 mid lateral scales. The caudal fin often has a rounded black spot at its base.

20.1.2 The Fishery

20.1.2.1 Utilization

This fish does not play a significant role in the livelihood of the local communities. However, it helps control propagation mosquito larvae in lakes and stagnant streams or water holes.

20.1.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water fish species in Vanuatu.

20.1.4 Management

20.1.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

20.1.4.2 Recommended legislation/policy regarding exploitation

It may be relevant for the Environment Unit and the Fisheries Department to carry out assessment studies to determine mechanisms to control propagation of this fish species.

20.2 FAMILY: POECILIIDAE (Liver Bearers)

20.2.1 The Resource

Species present
Gambusia affinis (Mosquito Fish)

20.2.1.1 Distribution

This species is a native to Gulf of Mexico and North America. The species is well established throughout the West tropical Indo-Pacific except for Australia where its possession is strictly prohibited.

It was introduced into Vanuatu to control mosquitoes by feeding on mosquito larvae. The species has been widely distributed by Health Authorities to almost all islands in Vanuatu, particularly in most densly populated areas where the incidence of malaria is high. It has established itself very well and is abundant in volcanic lakes including lake Siwi on Tanna and Waimemea on Ambae Island, swamps, ponds, small slow flowing streams.

20.2.1.2 Biology and ecology

This species preys on native fish and prawn larvae. They often attach large fish, nipping off their fins causing paralysis and eventually causing death.

20.2.2 The Fishery

20.2.2.1 Utilization

This fish does not play a significant role in the livelihood of the local communities. However, it helps control propagation mosquito larvae in lakes and stagnant streams or water holes.

20.2.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water fish species in Vanuatu.

20.2.4 Management

20.2.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

20.2.4.2 Recommended legislation/policy regarding exploitation

It may be relevant for the Environment Unit and the Fisheries Department to carry out assessment studies to determine mechanisms to control propagation of this fish species.

20.3 FAMILY: CICHLIDAE

20.3.1 The Resource

Species present
Oreochromis mossambica (Tilapia)

20.3.1.1 Distribution

This species is a native to eastern Africa. It was brought into Vanuatu to help control malaria. It slowly became an important food fish for rural communities. This fish is abundant in volcanic lakes such as Waimemea on Ambae, Siwi on Tanna. They are also abundant in large rivers and streams on Santo.

20.3.1.2 Biology and ecology

This species has a greenish colouration on the back of its body and silvery to grayish on its sides and a silvery white belly. It has an elongated dorsal fin containing 10-13 rays. Maximum average length is about 300 mm. Females practiced mouth brooding.

20.3.2 The Fishery

20.3.2.1 Utilization

This fish plays significant role in the livelihood of the local communities, particularly for nutrition purposes. They can easily become a pest due to their rapid breeding behaviour and ability to withstand water temperatures up to 40 Degree Celcius.

20.3.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water fish species in Vanuatu.

20.3.4 Management

20.3.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

20.3.4.2 Recommended legislation/policy regarding exploitation

It may be relevant for the Environment Unit and the Fisheries Department to carry out assessment studies to determine mechanisms to control propagation of this fish species.

20.4 FAMILY: CICHLIDAE

20.4.1 The Resource

Species present
Sarotherodon occidentalis (Tilapia)

20.4.1.1 Distribution

This species is a native of Senegal. It was brought into Vanuatu as an important food fish for rural communities. This fish is abundant in volcanic lakes such as Waimemea on Ambae, Siwi on Tanna. They are also abundant in large rivers and streams on Santo.

20.4.1.2 Biology and ecology

This species has 12 – 23 dorsal fin rays. It has a distinct lateral line with 30 – 32 sacles on the lateral line. Average body size have reached 100 mm, however may grow even bigger. Females and males practiced mouth brooding (ie habouring of young in mouth).

20.4.2 The Fishery

20.4.2.1 Utilization

This fish plays significant role in the livelihood of the local communities, particularly for nutrition purposes. They can easily become a pest due to their rapid breeding behaviour and ability to withstand rigorous environmental conditions.

20.4.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water fish species in Vanuatu.

20.4.4 Management

20.4.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

20.4.4.2 Recommended legislation/policy regarding exploitation

It may be relevant for the Environment Unit and the Fisheries Department to carry out assessment studies to determine mechanisms to control propagation of this fish species.

20.5 FAMILY: CYPRINIDAE

20.5.1 The Resource

Species present
Cyprinus sp. (Carps)

20.5.1.1 Distribution

This species is a native of east Asia. It was brought into Vanuatu as an important food fish for rural communities. This fish is abundant in lake Maniuro on Efate Island.

20.5.1.2 Biology and ecology

This species has an adverse influence on the environment because of their rapid breeding habits and their sucking mode of feeding which greatly disturbs the substratum causing turbidity in water. They compete with native species for food resources. Their main source of food is aquatic invertebrates.

The body colour is olive, bronze to gold and may have black blotches, silvery yellow on the belly. It has 26-31 lateral line scales. Its head is fairly triangular and lack scales. It has a distinct fort tail. Average body length is 160 mm however, may grow even bigger.

20.5.2 The Fishery

20.5.2.1 Utilization

This fish plays significant role in the livelihood of the local communities, particularly for nutrition purposes. They can easily become a pest due to their rapid breeding behaviour and ability to withstand rigorous environmental conditions and influence habitat environmental.

20.5.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water fish species in Vanuatu.

20.5.4 Management

20.5.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

20.5.4.2 Recommended legislation/policy regarding exploitation

It may be relevant for the Environment Unit and the Fisheries Department to carry out assessment studies to determine mechanisms to control propagation of this fish species.

21. COMMON FRESHWATER CRUSTACEANS

Vanuatu fresh water crustaceans comprises 18 species altogether. Eight species are prawns belonging to the Family **PALAEMONIDAE** and the genus *Macrobrachium*. There are nine species of the freshwater shrimps and one crab speices, Family **GRAPSIDAE**.

Freshwater prawns are widely spread throughout the islands and the larger species provide important source of protein for rural communities.

21.1 FAMILY PALAEMONIDAE

21.1.1 The Resource

Species present
Macrobrachium gracilirostre

21.1.1.1 Distribution

This species occurs in Taiwan, Indonesia, Paua New Guinea, Fiji and Samoa. It is wide spread in Vanuatu in all streams throughout the islands.

21.1.1.2 Biology and ecology

The species rostrum is slightly convex, with 6-7 teeth behind its eyes. Teeth are more widely spaced infornt of the eye. It has numerous dark green stripes along the body. The 2nd pereopodes are fairly equal in length ans similar in form. The carpus is longer than the merus. Maximum carapace length is about 25 mm.

21.1.2 The Fishery

21.1.2.1 Utilization:

This species plays significant role in the livelihood of the local communities, particularly for nutrition purposes.

21.1.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water prawn species in Vanuatu.

21.1.4 Managemenr

21.1.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

21.1.4.2 Recommended legislation/policy regarding exploitation

It may be not relevant at this stage to impose legislation for its management.

21.2 FAMILY PALAEMONIDAE

21.2.1 The Resource

Species present:
Macrobrachium latimanus

21.2.1.1 Distribution

This species is wide spread throughout the India, Sri Lanka, the Phillipines, Indonesia and eastward to the Marquises Islands. It is wide spread in Vanuatu in all streams throughout the islands.

21.2.1.2 Biology and ecology

The species is common throughout all pools of many streams, particularly the upper reaches and sometimes above waterfalls.

Males have well developed rostrum, which are slightly bent downwards. It has 2-3 teeth behind its eyes. Those infront of its eyes are more crowded. The 2nd pereopodes are more or less equal in length with the palm compressed to mass. The carpus is shorter than the merus. It has blue or dark spot on its tail. Maximum carapace length is about 30 mm.

21.2.2 The Fishery

21.2.2.1 Utilization

This species plays significant role in the livelihood of the local communities, particularly for nutrition purposes. It is often harvested on commercial bases for consumption at the domestic level.

21.2.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water prawn species in Vanuatu.

21.2.4 Management

21.2.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

21.2.4.2 Recommended legislation/policy regarding exploitation

It may be relevant at this stage to carry out assessment surveys to determine status of stocks.

21.3 FAMILY PALAEMONIDAE

21.3.1 The Resource

Species present:
Macrobrachium australe

21.3.1.1 Distribution

This species is wide spread throughout the Indian and Pacific regions. It is wide spread in Vanuatu in all streams throughout the islands.

21.3.1.2 Biology and ecology

The species is common throughout all pools of many streams, particularly in the lower section of the streams.

Its rostrum is curved upwards at the tip with 2-3 teeth behind its eyes. The upper edge has 9-13 teeth. The 2nd pereopodes are of different sizes. The carpus is longer than the merus. It has three distinct stripes (black or red) on its cephalothorax. Total body length is about 70-80 mm for females and 100-120 mm for males.

21.3.2 The Fishery

21.3.2.1 Utilization

This species plays a significant role in the livelihood of the local communities, particularly for nutrition purposes. It is often harvested on commercial bases for consumption at the domestic level.

21.3.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water prawn species in Vanuatu.

21.3.4 Management

21.3.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

21.3.4.2 Recommended legislation/policy regarding exploitation

It may be relevant at this stage to carry out assessment surveys to determine status of stocks.

21.4 FAMILY PALAEMONIDAE

21.4.1 The Resource

Species present
Macrobrachium lepidactyloides

21.4.1.1 Distribution

This species occurs in the Phillipines, Indonesia and Fiji. In Vanuatu it is only found on Santo and Malekula.

21.4.1.2 Biology and ecology

This species is rare. It is common in large streams often those stream near the coasts.

Its rostrum dorsal margin is slightly bent with 11 teeth unequally spaced. It has 7 teeth behind its eyes and 4 teeth infront of its eyes. The 2nd pereopodes have different length and sizes with palm compressed to mass. The carpus and the merus lengths are more or less equal. Maximum carapace length is about 25 mm.

21.4.2 The Fishery

21.4.2.1 Utilization

This species plays a significant role in the livelihood of the local communities, particularly for nutrition purposes.

21.4.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water prawn species in Vanuatu.

21.4.4 Management

21.4.4.1 Current legislation/policy regarding exploitation:

No current legislation to manage the exploitation of the resource

21.4.4.2 Recommended legislation/policy regarding exploitation:

It may be relevant at this stage to carry out assessment surveys to determine status of stocks.

21.5 FAMILY PALAEMONIDAE

21.5.1 The Resource

Species present
Macrobrachium placidulum

21.5.1.1 Distribution

This species is common in the Phillipines, Indonesia, Papua New Guinea, Bismarck Archipelago, Palau, and Fiji. In Vanuatu it is only found on Efate and Malekula.

21.5.1.2 Biology and ecology

This species occupies the lower parts of clear streams.

Its rostrum margin is slightly bent downward. The teeth are more widely spaced anteriorly than posteriorly. The 2nd pereopodes are unequal length. The carpus is shorter than the merus. This species may have a black stripe at the tail base. Maximum carapace length is about 20 mm.

21.5.2 The Fishery

21.5.2.1 Utilization:

This species plays a significant role in the livelihood of the local communities, particularly for nutrition purposes.

21.5.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water prawn species in Vanuatu.

21.5.4 Mangement

21.5.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

21.5.4.2 Recommended legislation/policy regarding exploitation

It may be relevant at this stage to carry out assessment surveys to determine status of stocks.

21.6 FAMILY PALAEMONIDAE

21.6.1 The Resource

Species present
Macrobrachium latidactylus

21.6.1.1 Distribution

This species is common in the Phillipines, Indonesia, Malaysia, and Taiwan. In Vanuatu it is only found on Santo and Malekula.

21.6.1.2 Biology and ecology

This species occupies the lower parts of large streams with bottom substate comprising mainly sand and gravel.

Its rostrum margin is slightly bent downward with 3-5 teeth behind its eyes. The 2nd pereopodes are unequal length and different forms. The carpus is longer than the merus. This species may have a black stripe at the tail base. Maximum carapace length is about 25 mm.

21.6.2 The Fishery

21.6.2.1 Utilization

This species plays a significant role in the livelihood of the local communities, particularly for nutrition purposes.

21.6.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water prawn species in Vanuatu.

21.6.4 Management

21.6.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

21.6.4.2 Recommended legislation/policy regarding exploitation

It may be relevant at this stage to carry out assessment surveys to determine status of stocks.

21.7 FAMILY GRAPSIDAE

21.7.1 The Resource

Species present
Varuna litterata

21.7.1.1 Distribution

This species is common East Africa, Japan and throughout the west Indo Pacific. In Vanuatu it is only found on Erromango, Pentecost and Efate.

21.7.1.2 Biology and ecology

This species occupies the lower parts of large streams with bottom substate comprising mainly sand and gravel.

Its carapace is slightly rectangular with a “H” mark on the back of its carapace. Body colouration is fairly reddish brown. Maximum carapace width is about 55 mm. Its legs have fine hair.

21.7.2 The Fishery

21.7.2.1 Utilization

This crab does not play a significant role in the livelihood of the local communities.

21.7.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water crab species in Vanuatu.

21.7.4 Management

21.7.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

21.7.4.2 Recommended legislation/policy regarding exploitation

It may not be relevant at this stage to carry out assessment surveys to determine status of stocks.

22 FRESH WATER EELS

The fresh water eels belong to the Family ANGUILLIDAE. There are more than 500 fish species (order Anguilliformes) that are slender, elongated, and usually scaleless, with long dorsal and anal fins that are continuous around the tail tip. They do not have pelvic fins but have a single fingle fin that extends around much of the body posterior.

Eels are found in all seas, from coastal regions to the mid-depths. Freshwater eels are active, predaceous fish with small embedded scales. They may take 10 to 20 years to reach sexual maturity before they migrate downstream to the sea to spawn and die. The transparent young drift to the coast and make their way upstream. Eels have a remarkable life cycle. Broadly, it consists of development and early growth in the open ocean: the planktonic (free-floating) dispersal of eggs and larvae, metamorphosis, juvenile and adult growth, and the migration of maturing adults to an oceanic spawning area.

They use their muscular bodies to slither up rapids and waterfalls towards the upper reaches of the streams from which they enter inland lakes, such as lake Letas on Gaua Island, Banks Torres. In many islands of Vanuatu eels are culturally significant species associated with streams and rivers. Freshwater eels, are considered valuable food fish for local communities, including species ranging from 4 in. (10 cm) to about 11.5 ft (3.5 m) long.

22.1 FAMILY ANGUILLIDAE

22.1.1 The Resource

Species present
Anguilla marmorata (Giant Long-finned Eel)
Phylum: *Chordata*
Subphylum: *Vertebrata*
Class: *Actinopterygii*
Order: *Anguilloidei*
Family: *Anguillidae*

22.1.1.1 Distribution:

Indo-Pacific: East Africa to French Polynesia, north to southern Japan. Africa: Inland waters: Mozambique and lower Zambezi river. This species is common throughout the Pacific Islands.
The eel fish is demersal and can occupy freshwater; brackish and marine environments between a depth range of 1 - 400 m. In Vanuatu it is found in all courses of streams and lakes throughout the islands.

22.1.1.2 Biology and ecology

Adults have a brownish to black marbling on their back on a greyish yellow background. This coloration can fade away. White belly. Younger specimens are greyish to orange and the marbling is less visible. Body color brown speckles scattered on back, sides and fins; yellow between speckles and edge of pectoral fin; belly white or pale blue. Head rounded; snout depressed; lower jaw protruded; gill openings small; scales matted-like under skin; pectoral fin rounded; pelvic fin absent. Distinguished from all other species by the mottled color and the long dorsal fin, which begins closer to the gill opening than to the anus.

This eel species is long-finned. They are generally brown with dark spots and mottling which increases with age. The maxillary tooth band is relatively narrow, consisting of 3 longtitudinal

rows of teeth with toothless grooves between each row. Maximum body length is recorded to be 100 cm. However, there are reports of this species growing over 100 cm in length.

Lives in freshwater areas as adults, estuaries and seas as young. Found in lowland rivers as well as upland tributaries. While in rivers, the sex gland of the fish does not develop and in winter it follows streams to river mouths where the sex gland begins to develop and afterwards it goes to deep sea to breed. Its spawning grounds are deepsea gullies among the south of the Philippines, east of Indonesia and Papua New Guinea. Inhabits deep rocky pools and is active at night, feeding on a wide range of prey, especially crabs, frogs and fish. Thought to breed east of Madagascar where the young are wafted to the East Coast by ocean currents.

This eel species has a very low, minimum population doubling time more than 14 years. It can reach a maximum weight of 20.5 kilograms and hs been reported to live up to 40 years.

This is a common eel species, which is found to inhabit all parts of streams in Vanuatu. They are able to penetrate upland waters that are connected by streams to the sea.

22.1.2 The Fishery

22.1.2.1 Utilization

This eel species has a commercial valaue and is commercially farmed. In Vanuatu the eel fish species play a significant role in the livelihood of the local communities. They are harvested by local communities and consumed locally as a source of protein.

22.1.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water fish species in Vanuatu. The eel fish is harmless therefore there are fears that local populations could be in danger of being overfished.

22.1.4 Management

22.1.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

22.1.4.2 Recommended legislation/policy regarding exploitation

Given its significant role as a food source, it is recommended that assessment surveys are carried out to determine status of stocks and thus formulate management measures.

22.2 FAMILY ANGUILLIDAE

22.2.1 The Resource

Species present

Anguilla megostoma (Pacific Long-finned Eel)

Phylum: *Chordata*
Subphylum: *Vertebrata*
Class: *Actinopterygii*
Order: *Anguilloidei*
Family: *Anguillidae*

22.2.1.1 Distribution

Pacific Ocean: Sulawesi, Indonesia to the Society Islands. Also recorded from Pitcairn. In general this species is common throughout the western and central Pacific region. In Vanuatu it is only found on Santo, Malekula, Gaua and Aneityum.

22.2.1.2 Biology and ecology

It is the only species that can be either variegated or plain-colored. Mottled individuals most closely resemble *Anguilla celebensis* and *A. interioris* in having broad, undivided tooth bands, but their ranges do not overlap. Plain-colored individuals most closely resemble *A. japonica* and *A. borneensis*, but those species both geographically distant. *A. obscura* is also plain-colored but has a shorter dorsal fin. The skin is grey to yellowish and more or less spotted with brown or black. It can be sometimes uniformly brownish red on the flanks and the back. The belly is white. Young specimens are grey and do not have spots. This eel species is also long-finned. They are generally brownish yellow in colour and have a large mouth. Average body length is recorded to be 430 mm, however, may grow to a maximum size of 100 cm weighing up to 9,000.0 grams

This eel species is found to inhabit all parts of streams above waterfalls, in rocky pools, springs and lakes.

22.2.2 The Fishery

22.2.2.1 Utilization

This eel species play a significant role in the livelihood of the local communities. They are harvested by local communities and consumed as a source of protein.

22.2.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water fish species in Vanuatu.

22.2.4 Management

22.2.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

22.2.4.2 Recommended legislation/policy regarding exploitation

Given its significant role as a food source it is recommended that assessment surveys are carried out to determine status of stocks and thus formulate management measures.

22.3 FAMILY ANGUILLIDAE

22.3.1 The Resource

Species present

Anguilla obscura (Pacific Short-finned eel)

Phylum: *Chordata*
Subphylum: *Vertebrata*
Class: *Actinopterygii*
Order: *Anguilloidei*
Family: *Anguillidae*

22.3.1.1 Distribution

Pacific Ocean: western New Guinea and Queensland, Australia to the Society Islands. A single specimen was recorded from a tributary of the Buffalo River, near King William's Town in South Africa, but this is questionable. This species is common throughout the western and central Pacific region. In Vanuatu it is only found on Santo and Gaua islands.

22.3.1.2 Biology and ecology

This eel species is found to inhabit estuaries and inland lakes. It belongs to the group of anguillas, which have a short dorsal fin, which originates slightly before the anus. Most closely resembles *Anguilla australis* and *A. bicolor*, from which it can be distinguished with certainty only by the number of vertebrae. This eel species is short-finned. They have a uniform dark brown colouration, which is lighter on the belly. Average body length is recorded to be 101.0 cm.

It is found in large turbid rivers and small creeks and occurs both in running and stagnant waters. This eel fish species feeds mainly on fishes, crustaceans and mollusks. It has a very low, minimum population doubling time of more than 14 years.

22.3.2 The Fishery

22.3.2.1 Utilization:

This eel species play a significant role in the livelihood of the local communities. They are harvested by local communities and consumed as a source of protein.

22.3.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water fish species in Vanuatu.

22.3.4 Management

22.3.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

22.3.4.2 Recommended legislation/policy regarding exploitation

Given its significant role as a food source, it is recommended that assessment surveys are carried out to determine status of stocks and thus formulate management measures.

22.4 FAMILY ANGUILLIDAE

22.4.1 The Resource

Species present
Anguilla reinhardti (Marbled Eel)
Phylum: *Chordata*
Subphylum: *Vertebrata*
Class: *Actinopterygii*
Order: *Anguilloidei*
Family: *Anguillidae*

22.4.1.1 Distribution

This species is found in Papua New Guinea, Eastern part of Australia including Tasmania, Lord Howe Isand, New Caledonia, and New Zealand. In Vanuatu it is only found on Vanua Lava and Gaua islands.

22.4.1.2 Biology and ecology

This eel species is relatively rare in Vanuatu. It occurs in coastal lagoons, rivers, streams, lakes, swamps and farm dams, but prefers riverine habitats. They are mainly nocturnal feeders feeding on crustaceans, mollusks, aquatic and terrestrial insects, fish including elvers and native trout.

Characterized by mottled color and tooth bands with a separated inner series. The only other species within its range with these characters is *Anguilla marmorata*, but that species has a longer dorsal fin. This eel species is long-finned. It has an olive green to brownish colouration with distinct darker blotching on its back and a longtitudinal row of dots on the sides. The belly has a pale grey or whitish colouration. The median fins are dark brown and yellowish pectoral fins. Average body length is recorded to be 200 cm. Its maximum recorded weight is 16.3 kilograms and can live up to 41 years and can release up to 5 million offsprings per season. It has a very low, minimum population doubling time more than 14 years.

22.4.2 The Fishery

22.4.2.1 Utilization

This eel species play a significant role in the livelihood of the local communities. They are harvested by local communities and consumed as a source of protein.

22.4.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water fish species in Vanuatu.

22.4.4 Management

22.4.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

22.4.4.2 Recommended legislation/policy regarding exploitation

Given its significant role as a food source, it is recommended that assessment surveys are carried out to determine status of stocks and thus formulate management measures.

22.5 FAMILY MURAENIDAE (Moray Eels)

22.5.1 The Resource

Species present
Gymnothorax polyuranodon (Freshwater Moray eel)

22.5.1.1 Distribution

This species is found in Indonesia, Fiji and northern Australia. In Vanuatu it is only found on Malekula, Epi and Erromango islands.

22.5.1.2 Biology and ecology

This eel species inhabits river mouths close to the sea.

This eel species has a snake-like body shape. Its dorsal fin is located above or infront of its gill opening. It has a yellowish brown body colouration with large irregular round black bloteches on the body, which are joined to form longtitudinal dark bands on its head. Average body length is recorded to be 800 mm.

22.5.2 The Fishery

22.5.2.1 Utilization

This eel species does not play a very significant role in the livelihood of the local communities.

22.5.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water fish species in Vanuatu.

22.5.4 Management

22.5.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

22.5.4.2 Recommended legislation/policy regarding exploitation

Given its lack of importance as a food source, it is recommended that it is not necessary at this stage to carry out assessment surveys determine status of stocks.

22.6 FAMILY OPHICHTIDAE

22.6.1 The Resource

Species present
Achirophichthys kampeni (Freshwater Snake-eel)

22.6.1.1 Distribution

This is a rare eel species and is found only in Papua New Guinea. In Vanuatu it is only found on Malekula, Maewo and Santo.

22.6.1.2 Biology and ecology

This eel species inhabits coastal streams with sandy substrates. It burrows into the sandy substrates for shelter.

This eel species has a long slender body and pointed snout. Origin of its dorsal fin is slightly behind its gill openings. It lacks scales, but has white pores forming a lateral line on the body. Its dorsal is grayish in colour and whitish ventrally. Average body length is recorded to be 310 mm.

22.6.2 The Fishery

22.6.2.1 Utilization

This eel species does not play a very significant role in the livelihood of the local communities.

22.6.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water fish species in Vanuatu.

22.6.4 Management

22.6.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

22.6.4.2 Recommended legislation/policy regarding exploitation

Given its lack of importance as a food source, it is recommended that it is not necessary at this stage to carry out assessment surveys determine status of stocks.

22.7 FAMILY OPHICHTIDAE

22.7.1 The Resource

Species present
Lamnostona polythalmus

22.7.1.1 Distribution

This eel species is also rare and is found only Epi and Efate.

22.7.1.2 Biology and ecology

This eel species inhabits river mouths and burrows into sandy bottom substrates.

This eel species has a long slender worm-like body and pointed snout. Origin of its dorsal fin is slightly behind its gill openings. It lacks scales. Average body length is recorded to be 290 mm.

22.7.2 The Fishery

22.7.2.1 Utilization

This eel species does not play a very significant role in the livelihood of the local communities.

22.7.3 Stocks Status

No stock assessment surveys have been carried out to determine the population dynamics and the status of stocks of this fresh water fish species in Vanuatu.

22.7.4 Management

22.7.4.1 Current legislation/policy regarding exploitation

No current legislation to manage the exploitation of the resource

22.7.4.2 Recommended legislation/policy regarding exploitation

Given its lack of importance as a food source, it is recommended that it is not necessary at this stage to carry out assessment surveys determine status of stocks.

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